AGRICULTURAL RESEARCH INSTITUTE

PUSA

	Page
Further Observations on the Breeding Habits and Control of the House-Fly, *Musca domestica*	281
W. E. Hinds. County Organization in the Campaign against the Boll Weevil	65
Reducing Insect Injury to Stored Corn	203
H. E. Hodgkiss and P. J. Parrott. The Parasites of the San José Scale in New York	227
L. O. Howard. A Note on Sigismond Mokshetsky and His Work in the Crimea	247
An Incident in the Search for Foreign Gipsy-Moth Parasites	378
The Education of the Entomologists in the Service of the U. S. Department of Agriculture	275
S. J. Hunter and P. W. Claassen. Grasshopper Control in the Southern Division of Kansas	73
W. D. Hunter. Quarantine against the Mexican Cotton Boll Weevil	234
S. J. Hunter. The Sandfly and Pellagra, III	293
J. A. Hyslop. Soil Fumigation	305
J. F. Illingworth. Further Notes on the Breeding of the Tachinid Fly Parasitic on the Cane Beetle Borer	390
A New Pest of Cane in Fiji, *Sphenophorus nebulosus* Mcly	444
T. H. Jones. Additional Notes on Porto Rican Sugar-cane Insects	461
E. O. G. Kelly. Notes on the Biology of *Diplazon lætatorius*	294
G. B. King. A New Species of Kermes from Connecticut	150
The Genus Pseudokermes in Montana	246
J. L. King. Contributions to the Life History of the Lesser Peach Borer in Ohio	401
Robert Matheson. The San José Scale in Nova Scotia	141
J. W. McColloch and H. Yuasa. A Parasite of the Chinch Bug Egg	219
E. A. McGregor. Red Spider Control	324
The Serpentine Leaf-miner on Cotton	447
A. L. Melander. Can Insects Become Resistant to Sprays?	167
C. L. Metcalf. Egg-Laying Habits of the Pecan Twig Girdler	218
Z. P. Metcalf. Report of Field Work on Southern Corn Bill Bug*	83
A. W. Morrill. Experiments with House-Fly Baits and Poisons	268

*Withdrawn for publication elsewhere.

PAGE

F. H. MOSHER and R. T. WEBBER. The Relation of Variation in the Number of Larval Stages to Sex Development in the Gipsy Moth 368

WILMON NEWELL. A Simple and Economical Method of Filing Entomological Correspondence 87

The Essentials of a Good Apiary Inspection Law 92

A Natural Enemy of the Argentine Ant 147

W. C. O'KANE. Further Experience with an Insectary 181

W. A. ORTON. Plant Quarantine Problems 109

HERBERT OSBORN. Economic Notes on Leaf Hoppers in Maine* 192

F. B. PADDOCK. Observations on the Bee-moth 153

J. R. PARKER. The Life History of the Sugar-beet Root-louse, *Pemphigus betæ* 136

T. H. PARKS. Effect of Temperature upon the Oviposition of the Alfalfa Weevil, *Phytonomus posticus* Gyll. 417

P. J. PARROTT. The Growth and Organization of Applied Entomology in the United States 50

L. M. PEAIRS. The Relation of Temperature to Insect Development 174

D. M. ROGERS. The Gipsy and Brown-tail Moth Quarantine 116

S. A. ROHWER. Description of a New Sawfly Injurious to Strawberries 479

E. W. RUST. Notes on Coccidæ Found in Peru 467

J. G. SANDERS. Uniform State Inspection Laws 102

E. R. SASSCER. Notes on Entomological Inspection in the District of Columbia 240

W. M. SCOTT. The California Pear Thrips in Maryland 478

V. E. SHELFORD. The Importance of the Measure of Evaporation in Economic Studies of Insects 229

The Use of Atmometers to Measure Evaporation in the Study of Insects 249

PERLEY SPAULDING. Inspection for Plant Diseases 106

O. H. SWEZEY. The Introduction of a Tachinid Parasite of the Sugar Cane Weevil Borer in Hawaii 455

H. V. TARTAR. On the Valuation of Lime-sulfur as an Insecticide 463

D. G. TOWER. Notes on the Life History of *Prospaltella perniciosi* Tower 422

*Withdrawn for publication elsewhere.

PAGE

C. H. T. TOWNSEND. Progress of Verruga Work with *Phlebotomus verrucarum* T. 357

F. L. WASHBURN. Today's Work in Applied Entomology* 64

F. L. WASHBURN and A. J. SPANGLER. A Few Problems in Connection with the Administration of the Minnesota Inspection Law 119

J. L. WEBB. Notes on the Rice Water-weevil, *Lissorhoptrus simplex* 432

F. M. WEBSTER. An Unrecorded Parasite of *Toxoptera graminum* 403

H. B. WEISS. *Agrilus politus* Say Infesting Roses 438

R. D. WHITMARSH. The Green Soldier Bug, *Nezara hilaris* 336

G. N. WOLCOTT. Notes on the Life History and Ecology of *Tiphia inornata* Say 382

W. C. WOODS. A Note on *Rhagoletis pomonella* in Blueberries 398

*Withdrawn for publication elsewhere.

TWENTY-SEVENTH ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Philadelphia, Pa., December 28 to 31, 1914

The twenty-seventh annual meeting of the American Association of Economic Entomologists will be held at the University of Pennsylvania, Philadelphia, Pa., beginning December 28 and ending December 31, 1914. The meetings will be held in classroom D of the Veterinary Building, 39th Street and Woodland Avenue, Philadelphia. The opening session will begin at 1.30 p. m., Monday, December 28, when the annual reports and reports of committees will be presented and the address of the president delivered. The meeting of the general association will be continued on Tuesday at 10 a. m., 1. 30 p. m., and on Wednesday at 1.30 p. m. The final session will be held on Thursday morning at 10 a. m.

Sectional Meetings

The meeting of the section on Apiary Inspection will be held at 8 p. m. Monday, December 28, at which time the regular business of the section will be transacted and a program of papers presented.

The meeting of the section on Horticultural Inspection will be held Tuesday at 8 p. m., and Wednesday morning at 10 a. m.

Other Meetings

The American Association for the Advancement of Science and its affiliated societies will hold meetings throughout the week. The meeting of the Entomological Society of America will begin on Thursday at 10 a. m. The public lecture before that society will be delivered Wednesday evening, December 30, by Dr. Stephen A. Forbes, state entomologist of Illinois. His subject will be "The Ecological Foundations of Applied Entomology." Dr. Henry Skinner will also present "A History of the Entomological Society of America." The American Society of Zoölogists will meet December 29 to 31, and the American Society of Naturalists, December 31, in the zoölogical laboratory on the opposite side of Woodland Avenue from the Veterinary Building. The Botanical Society of America will meet December 29 to 31; the American Phyto-pathological Society, December 30 to January 1, and Section G, botany, of the American Association will meet December 29 in the medical laboratory on Hamilton Walk, two blocks

from the Veterinary Building. The annual dinner of the naturalists will take place Thursday evening, December 31. The University of Pennsylvania extends a cordial invitation to the members of the American Association and all affiliated societies to take lunch at the gymnasium on 33d and Spruce Streets, as its guests. The gymnasium may be reached from the Veterinary Building direct by electric cars on route 40, east bound on Spruce Street, one block north.

Smoker

The entomologists of Philadelphia are planning to hold a "smoker" for all visiting entomologists which will be held in the rooms of the American Entomological Society immediately following the public address.

Hotel Headquarters

Hotel headquarters of this Association and the Entomological Society of America will be at Hotel Walton, Broad and Locust streets. The prices for rooms only: single rooms, one person, without bath, $1.50 and up per day, or with bath $2.00 and up; double rooms, without bath, two persons, $3.00 and up, with bath, $3.50 and up, per day. The rooms have hot and cold running water. The Walton is three blocks from the Pennsylvania R. R. (Broad Street Station), five blocks from the Pennsylvania and Reading R. R. (Market Street Station), eleven blocks from the B. & O. R. R. (23d and Chestnut Street Station). As there will be a large attendance at the meeting, rooms should be engaged well in advance.

Railroad Rates

Exact data in regard to railroad rates are not available. Members should consult their local ticket agents or agents in the nearest large cities where reductions in rates are likely to apply. Information can undoubtedly be secured from the regular announcement of the meeting by the American Association for the Advancement of Science.

Official Buttons

Official buttons of the Association will be furnished to members at the time of the meeting by application to the Secretary.

Membership

Application blanks for membership may be secured from the Secretary.

Program

Monday, December 28, 1914, 1.30 p. m.

Report of the Secretary.

Report of executive committee, by President Fernald.

Report of employment bureau, by W. E. Hinds, Auburn, Ala.

Report of committee on nomenclature, by Herbert Osborn, Columbus, Ohio.

Report of committee on entomological investigations, by T. J. Headlee, New Brunswick, N. J.

Report of committee on bibliography of economic entomology, by E. P. Felt, Albany, N. Y.

Appointment of committees.

Miscellaneous business.

Action on the following proposed amendment to the by-laws:

Article III, Section I of the by-laws reads as follows: "The annual dues of active members shall be one dollar and the dues of associate members 50 cents, which shall be payable in advance. No dues shall be payable from foreign members. Annual dues shall not include subscription to the JOURNAL OF ECONOMIC ENTOMOLOGY."

The proposal is to strike out this and substitute the following: "The annual dues of active members shall be two dollars, and the dues of associate members one dollar, which shall be payable in advance. No dues shall be payable from foreign members. Annual dues shall not include subscriptions to the JOURNAL OF ECONOMIC ENTOMOLOGY."

New business.

Annual address of the President, H. T. Fernald, Amherst, Mass. "Some Present Needs of Economic Entomology."

READING OF PAPERS

"The Problems Involved in the Practical Work of Controlling the Mosquito Pest within the Limits of a County," by T. J. Headlee, New Brunswick, N. J. (15 minutes.) Lantern.

A brief statement of the problems and methods of meeting them. Based on two years' experience with such work.

"A Review of the Spotted Fever Tick in Montana," by R. A. Cooley, Bozeman, Mont. (15 minutes.) Lantern.

"Flies which Cause Myiasis in Animals—Some Aspects of the Problem," by F. C. Bishopp, Dallas, Texas. (15 minutes.)

"The Academic Training of the Entomologists in Colleges and Experiment Stations of the United States," by W. E. Britton, New Haven, Conn. (15 minutes.)

"Suggestions as to the Original Habitat and Distribution of Various Native Insect Pests," by V. E. Shelford, Urbana, Ill. (15 minutes.) Lantern.

Adjournment.

SECTION OF APIARY INSPECTION

WILMON NEWELL, *Chairman.* N. E. SHAW, *Secretary.*

Program

Monday, December 28, 8 p. m.

Address by the Chairman, Wilmon Newell, College Station, Tex.

Five-minute talks on apiary inspection work and foul brood situation in different states by apiary inspectors.

"Distribution of American Foul Brood and European Foul Brood in the United States," by E. F. Phillips, Washington, D. C.

"A Simple Record System for Apiary Inspection," by W. E. Britton, New Haven, Conn.

"Inspection as a Unit in the Massachusetts Apicultural Service," by Burton F. Gates, Amherst, Mass.

Adjournment.

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Program

Tuesday, December 29, 10 a. m.

Discussion of the Presidential Address

READING OF PAPERS

"The Life History of Oberea ulmicola (?)," by A. G. Ruggles, St. Paul, Minn. (10 minutes.)

"The Brown-tail Moth in Canada," by C. G. Hewitt, Ottawa, Can. (15 minutes.) Lantern.

The introduction and present status of the insect in Canada, with an account of the preventive and eradicative measures.

"Contact Sprays for Brown-tail Caterpillars," by C. H. Hadley, Jr. Durham, N. H. (5 minutes.)

Results of spraying young brown-tail caterpillars in the spring with various contact sprays of different strengths.

"*Tenuipalpus bioculatus* McG.—A Serious Pest to Privet Hedges," by E. A. McGregor, Batesburg, S. C. (5 minutes.)

Description of pest's work with notes on life history, habits and methods of control.

"Fumigation for the Box Leaf Miner," by E. P. Felt, Albany, N. Y. (8 minutes.)

A summary of the effects of various fumigants upon both plant and insect.

"Notes on Plant Lice having Alternate Food Habits," by C. P. Gillette, Fort Collins, Col. (15 minutes.)

Brief discussion of a few species, worked out at the Station, that have alternate food habits.

Adjournment.

Program

Tuesday, December 29, 1.30 p. m.

Reading of Papers

"A New Air Conditioning Apparatus," by George A. Dean, and R. K. Nabours, Manhattan, Kans. (10 minutes.) Lantern.

An illustrated description of the air conditioning machine and breeding chamber.

"The Moisture Factor in Relation to Insects," by A. F. Conradi, Clemson College, S. C. (5 minutes.)

A brief presentation of the moisture temperature relation in insect activity.

"Spraying Scheme for the Control of Insect Pests," by W. W. Yothers, Orlando, Fla. (5 minutes.)

This paper gives approximate dates to spray to produce best results.

"The Citricola Scale (*Coccus citricola*)," by H. J. Quayle, Riverside, Cal. (8 minutes.)

A summary account of the insect from the economic viewpoint.

"An Analysis of Spraying Methods against the Codling Moth," by P. J. Parrott, Geneva, N. Y. (10 minutes.) Lantern.

Brief discussion of preliminary experiments on eastern and western methods of spraying and to some factors that should be considered in the employment of a driving spray in commercial apple orchards in New York.

"Apple Leaf Roller in Utah," by E. G. Titus, Logan, Utah. (10 minutes.) Lantern.

Brief résumé of experimental work carried on against this insect during the present season.

"Further Data on the Control of the Fruit-Tree Leaf-Roller (*Archips argyrospila*)," by Glenn W. Herrick, Ithaca, N. Y. (15 minutes.)

"The Apple Flea Weevil (*Orchestes canus*)," by P. W. Glenn, Urbana, Ill. (10 minutes.) Lantern.

General account of occurrence in Illinois. Life history, habits, and methods of control.

"Preliminary Report on the Woolly Aphis," by E. N. Cory, College Park, Md. (10 minutes.)

Report of control measures investigated.

"Arsenical Residues on Fruit and Grass," by W. C. O'Kane, Durham, N. H. (12 minutes.)

Summary of further experiments to determine the residues on fruit, foliage, and grass after spraying with arsenate of lead, and the possible danger of poisoning human beings or livestock.

"Kerosene Traps as a Means of Checking up the Effectiveness of a Poisoned Bait Spray to Control the Mediterranean Fruit-Fly (*Ceratitis capitata* Wied.) with a Record of Beneficial Insects Captured in the Kerosene," by H. H. P. Severin and H. C. Severin, Marietta, Ohio. (To be read by title.)

"The Work of the Cotton Worms and Moth in Missouri," by L. Haseman, Columbia, Mo. (10 minutes.) Lantern.

Brief notes on the work of the pest on cotton and injury to fruit; also notes on development of the pest and control measures.

"The Cranberry Root Worm," by H. B. Scammell, Pemberton, N. J. (10 minutes.)

History, distribution, life history and habits, with recommendations for control.

"Arsenate of Lime as an Insecticide," by W. M. Scott, Baltimore, Md. (10 minutes.)

Report on the use of arsenate of lime as a substitute for arsenate of lead in the control of the codling moth and certain shade tree insects.

"Frauds, Semi-Frauds, and Questionables," by H. A. Surface, Harrisburg, Pa. (15 minutes.)

Brief discussion on the difficulties met by an economic zoölogist in combating materials of more or less questionable value, recommended as insecticides.

Adjournment.

SECTION OF HORTICULTURAL INSPECTION

W. E. Britton, *Chairman*. J. G. Sanders, *Secretary*.

Program

Tuesday, December 29, 8 p. m.

(Detailed program of this section will be available at the meeting.)

Wednesday, December 30, 10 a. m.

(Detailed program will be available at the meeting.)

AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

Program

Wednesday, December 30, 1.30 p. m.

Reading of Papers

"The Nicotine Sulphate—Bordeaux Combination," by V. I. Safro, Louisville, Ky. (15 minutes.)

"Insecticidal Properties of Various Sulphides and Polysulphides," by P. J. Parrott and W. J. Schoene, Geneva, N. Y. (5 minutes.)

This paper will deal with the results of experiments with insecticides containing sulphides and polysulphides of sodium, potassium, calcium, and barium as regards effectiveness against various injurious insects.

"A New Contact Insecticide," by W. M. Scott, Baltimore, Md. (15 minutes.)

Results of experiments in the use of a dry barium sulphur compound as compared with lime-sulphur solution for the control of the San José scale and the oyster-shell scale.

"Recent Results in the Use of Dust Sprays for Controlling the Corn-Ear Worm," by J. W. McCulloch, Manhattan, Kans. (7 minutes.) Lantern.

Results of experiments using dust sprays.

"The Corn-Ear Worm and Its Control," by L. Haseman, Columbia, Mo. (10 minutes.) Lantern.

A brief discussion of the pest; its work, and treatment for control.

"Further Use of Poisoned Bran Mash Flavored with Fruit Juice for Controlling Insects," by George A. Dean, Manhattan, Kans. (12 minutes.) Lantern.

This paper deals with the effectiveness of this bait in controlling army worms invading fields and gardens; also in controlling variegated cutworms, black crickets, and grasshoppers.

"Grasshopper Control in New York State," by E. P. Felt, Albany, N. Y. (8 minutes.)

Observations on a grasshopper outbreak and methods of control.

"Results of Wire-Worm Investigations," by A. F. Conradi, Clemson College, S. C. (5 minutes.)

Life history and control of the wire-worms, *Horistonotus uhleri* and *Monocrepidius vespertinus* in South Carolina.

"Notes on Insects Attacking Sudan Grass," by Wilmon Newell, College Station, Tex. (10 minutes.)

Information concerning well-known insects attacking Sudan grass, an important forage crop of the semi-arid Southwest.

"Some Economic Results of the Year," by S. J. Hunter, Lawrence, Kans. (12 minutes.)

"An Unique Type of Insect Injury," by W. R. McConnell, Hagerstown, Md. (10 minutes.)

An account of an insect which prevents the proper functioning of the root-nodules of certain legumes.

"A Mechanical Measure for Controlling the Flea-Beetle (*Epitrix fuscula*) on Potato," by C. L. Metcalf, Columbus, Ohio. (10 minutes.) Lantern.

"An Outbreak of the Alfalfa Looper (*Autographa gamma Californica* Speyer)," by J. R. Parker, Bozeman, Mont. (7 minutes.)

Adjournment.

Program

Thursday, December 31, 10 a. m.

Reading of Papers

"The Habits of Sarcophagidæ," by J. M. Aldrich, La Fayette, Ind. (10 minutes.)

"Further Data on the Life Economy of the Chinch Bug Egg Parasite," by J. W. McCulloch, Manhattan, Kans. (12 minutes.)

This paper gives the results of the life history studies of the past summer.

"Efficiency of Parasites of the San José Scale," by H. A. Surface, Harrisburg, Pa. (15 minutes.) Lantern.

An outline on the efficiency of parasites in cleaning up this pest; their natural spread in Pennsylvania, and their successful dissemination by artificial means.

"Notes on Onion Maggot in 1914," by A. I. Bourne.

Brief notes on work of present season's progress in the scout for practical methods of control.

"Life History, Natural Enemies and the Poisoned Bait Spray as a Method of Control of the Imported Onion Fly (*Pegomya cepetorum* Meade), with Notes on Other Onion Pests," by H. H. P. Severin and H. C. Severin, Marietta, Ohio. (15 minutes.)

"Insects of the Year in Utah," by E. G. Titus, Logan, Utah. (5 minutes.)

Principal insects causing damage this year noted on account of unusual character of some outbreaks.

Final Business

Report of committee on auditing.
Report of committee on resolutions.
Report of committee on membership.
Report of other committees.
Nomination of JOURNAL officers by Advisory Committee.
Report of committee on nominations.
Election of officers.
Miscellaneous business.
Fixing the time and place of next meeting.
Final adjournment.

A. F. BURGESS, *Secretary*.
Melrose Highlands, Mass.

H. T. FERNALD, *President*,
Amherst, Mass.

JOURNAL
OF
ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

VOL. 7 FEBRUARY, 1914 No. 1

Proceedings of the Twenty-sixth Annual Meeting of the American Association of Economic Entomologists

The twenty-sixth annual meeting of the American Association of Economic Entomologists was held at the Atlanta Medical College, Atlanta, Ga., December 31, 1913, to January 2, 1914.

The meeting of the section on Apiary Inspection was held at 10.30 a. m., January 1, and the section on Horticultural Inspection at 1.30 p. m., at the same Institution, and an adjourned session was held in the evening at the Ansley Hotel.

The business proceedings of the Association is given in Part I, while the addresses, papers, and discussions will be found in Part II of this report.

The proceedings of the sections will be prepared by the section secretaries and published as parts of this report.

PART I BUSINESS PROCEEDINGS

The meeting was called to order by President P. J. Parrott at 1.30 p. m., Wednesday, December 31, 1913.

The attendance at the meeting averaged about 100 members and visitors. The following members were present:

J. M. Aldrich, Lafayette, Ind.
George G. Atwood, Albany, N. Y.
G. M. Bentley, Knoxville, Tenn.
E. W. Berger, Gainesville, Fla.
W. E. Britton, New Haven, Conn.
J. E. Buck, Auburn, Ala.
A. F. Burgess, Melrose Highlands, Mass.
W. W. Chase, Atlanta, Ga.
P. W. Claason, Lawrence, Kan.
S. C. Clapp, Raleigh, N. C.
A. F. Conradi, Clemson College, S. C.
Mel T. Cook, New Brunswick, N. J.
R. A. Cooley, Bozeman, Mont.
E. C. Cotton, Knoxville, Tenn.
J. J. Culver, Melrose Highlands, Mass.
George A. Dean, Manhattan, Kan.
J. A. Dew, Auburn, Ala.
E. P. Felt, Albany, N. Y.

H. T. Fernald, Amherst, Mass.
E. H. Gibson, Greenwood, Miss.
P. A. Glenn, Urbana, Ill.
R. W. Harned, Agricultural College, Miss.
T. J. Headlee, New Brunswick, N. J.
Glenn W. Herrick, Ithaca, N. Y.
C. Gordon Hewitt, Ottawa, Canada.
W. E. Hinds, Auburn, Ala.
T. E. Holloway, Audubon Park, La.
J. R. Horton, New Orleans, La.
J. S. Houser, Wooster, Ohio.
L. O. Howard, Washington, D. C.
S. J. Hunter, Lawrence, Kan.
W. D. Hunter, Washington, D. C.
A. H. Jennings, Washington, D. C.
R. W. Leiby, Ithaca, N. Y.
A. C. Lewis, Atlanta, Ga.
U. C. Loftin, New Orleans, La.
A. D. MacGillivray, Urbana, Ill.
C. L. Marlatt, Washington, D. C.
P. W. Mason, Lafayette, Ind.
J. W. McColloch, Manhattan, Kan.
E. A. McGregor, Batesburg, S. C.
A. L. Melander, Pullman, Wash.
C. L. Metcalf, Raleigh, N. C.
Z. P. Metcalf, West Raleigh, N. C.
A. W. Morrill, Phoenix, Ariz.
Wilmon Newell, College Station, Texas.
W. C. O'Kane, Durham, N. H.
Herbert Osborn, Columbus, Ohio.
F. B. Paddock, College Station, Texas.
P. J. Parrott, Geneva, N. Y.
L. M. Peairs, Morgantown, W. Va.
R. H. Pettit, East Lansing, Mich.
W. V. Reed, Atlanta, Ga.
W. A. Riley, Ithaca, N. Y.
W. E. Rumsey, Morgantown, W. Va.
J. G. Sanders, Madison, Wis.
E. R. Sasscer, Washington, D. C.
W. J. Schoene, Blacksburg, Va.
W. M. Scott, Baltimore, Md.
N. E. Shaw, Columbus, Ohio.
V. E. Shelford, Chicago, Ill.
Franklin Sherman, Jr., Raleigh, N. C.
Henry Skinner, Philadelphia, Pa.
A. J. Spangler, St. Anthony Park, Minn.
Charles Spooner, Atlanta, Ga.
H. E. Summers, Ames, Iowa.
F. L. Washburn, St. Anthony Park, Minn.
W. M. Wheeler, Boston, Mass.
G. N. Wolcott, Dallas, Tex.
E. L. Worsham, Atlanta, Ga.
W. W. Yothers, Orlando, Fla.

President P. J. Parrott: I have the honor of calling together the twenty-sixth annual meeting of this Association, and we will first listen to the report of the Secretary.

REPORT OF THE SECRETARY

The membership in the Association has been slightly increased during the past year. Since the Cleveland meeting two active, two associate, and one foreign member have died, and two active and four associate members have been dropped from the rolls on account of non-payment of dues.

The total membership to date is 131 active, 189 associate and 53 foreign, which makes a net gain for the year of 24 members.

On February 23, 1913, Miss Marie E. Murtfeldt, one of the pioneer members of this Association, died at her home at Kirkland, Mo.

February 12, 1913, Mr. C. W. Hooker died following an operation for appendicitis at Mayaguez, P. R.

August 18, 1913, Mr. Harry Pinkus died at Dallas, Texas.

October 15, 1913, Mr. A. G. Hammar died as a result of being accidentally shot while on a gunning expedition.

September 2, 1913, Mr. Enzio Reuter of Helsingfors, Finland, died.

Suggestions Concerning the Journal

The subscription list of the Journal has increased slightly during the past year, but not as much as should have been the case. The secretary would suggest that the members of the Association can contribute materially to the success of the Journal by influencing people who are interested in entomology to become subscribers. It is practically impossible for the editorial staff to make a thorough canvass and obtain as many subscribers as ought to be on our list. If the members will interest themselves in this matter the number of subscribers should be materially increased during the coming year. Every institution in which entomology is studied, and most libraries, could use this publication profitably, and it is hoped that the members will assist in increasing the number of our subscribers by advising any institutions or libraries with which they may be connected, to subscribe for our publication.

During the past year the first two numbers of the Journal contained a large number of pages in order that the proceedings of the annual meeting might be published promptly. If the page numbers had been kept down to the number usually contained in an issue, some of the papers presented at the meeting would not have been published before June or August.

Financial Statement

The following statement shows a balance in favor of the Association. It does not indicate, however, a number of liabilities which must be met within the next month. Practically all the bills incurred by the Journal have been paid except the cost of printing the last issue.

A large number of the members have already paid their dues and subscription to the Journal for the year 1914. If all Association bills had been paid at the time our books were closed, the expenditures and receipts for the year would practically balance.

Association Statement

Balance in Treasury, December 23, 1912		$319.26
By amount received for dues, etc., 1913		227.96
To stenographic report 1912 meeting	$25.00	
Stamps and stamped envelopes	35.20	
Printing	37.50	
Printing, Committee on Entomological Investigations	8.80	
Committee on Incorporation	1.44	
Telegraph and express	3.74	
Clerical work, Secretary's office	26.75	
One-half salary of Secretary	50.00	
	$188.43	
Balance, December 22, 1913	358.79	
	$547.22	$547.22

Journal Statement

Balance in Treasury, December 18, 1912		$223.81
By amount received from subscriptions, advertising, etc., 1913		1,802.38
To Stamps and stamped envelopes	$43.75	
Printing	1,272.53	
Halftones, etc.	92.85	
Telegraph and express	1.05	

Miscellaneous supplies	$15.20	
Clerical work Editor's office	70.00	
Clerical work Manager's office	45.00	
Salary, Editor	100.00	
One-half salary of Manager	50.00	
	$1,690.38	
Balance in Treasury, December 22, 1913	335.81	
	$2,026.19	$2,026.19

Respectfully submitted,

A. F. Burgess,
Secretary.

On motion the report was received and the financial part referred to the auditing committee.

President P. J. Parrott: I will read the report of the Executive Committee.

REPORT OF THE EXECUTIVE COMMITTEE

December 31, 1913.

To the American Association of Economic Entomologists:

Gentlemen:—As there has been no apparent necessity for a meeting, the Executive Committee has conducted its work by personal interview of individual members and by correspondence, and begs to present the following report:

By the vote of the Association at its last meeting the invitation from the directors of the Panama-Pacific Universal Exposition for this Association to hold its sessions in 1915 at the Exposition in San Francisco was referred to the Executive Committee for action. The Executive Committee authorized the Secretary, in his acknowledgment of the invitation to inform the Executive Officer of the Exposition that it was the custom of the Association to hold its yearly meeting in connection with the annual assembly of the American Association for the Advancement of Science and that, as in the past, the location of the meeting of this organization for that year would undoubtedly be governed by the movements of the latter association.

The resolution of this Association, relative to the organization of the International Congress of Entomologists, in which emphasis was specially laid upon the desirability of the adoption of a constitution at an early date with provisions for delegate representation and adequate voting power of the various entomological societies of the world, was forwarded by your Secretary in due season to the officers of the next congress.

In accordance with the resolution of the special committee on Bibliography of Economic Entomology, the Executive Committee brought to the attention of the Honorable Secretary of Agriculture the importance and desirability of the publication up to date of this most useful work. Failing in this attempt, nothing further was done with this matter until the change of administration, when the proposition was kindly placed by Mr. C. L. Marlatt before the committees appointed by the present Secretary, who directs the publications of the Department of Agriculture. The Executive Committee was later informed that the adoption of entirely new regulations governing the publications of this Department made it quite unlikely that the compilation and publication of the Bibliography of Economic Entomology would

be continued, as there seems to be no provision in the new plans for publications of this character. Therefore, following the suggestion in the report of the special committee, a committee of three members consisting of Dr. W. E. Britton, Dr. E. P. Felt and Mr. J. J. Davis were appointed to consider the question of maintaining the bibliography by other means. That committee will present a statement at this meeting.

The Second International Congress of Entomology at Oxford, during 1913, unanimously passed certain resolutions creating and directing an International Committee on Nomenclature. One of the duties of this committee is to enter into communication with the entomological societies of the world in order to form national committees on nomenclature. At the request of Dr. Karl Jordan, Secretary of the International Committee, who has performed this service for the European societies Mr. Nathan Banks consented to undertake similar work for the American organizations. As Mr. Banks desired the appointment of two members from the Association of Economic Entomologists to serve on the American National Committee, the President asked Professor Herbert Osborn and Dr. A. D. MacGillivray to act in this capacity, which they consented to do.

The resolution, regretting the discontinuance of the reviews of the principal injurious insects of the year as formerly published in the Yearbook of the Department of Agriculture, and petitioning the Chief of the Bureau of Entomology to prepare such for publication in the JOURNAL OF ECONOMIC ENTOMOLOGY, was brought to the attention of Dr. L. O. Howard by the Executive Committee. Doctor Howard informed the committee that he would gladly furnish such a review, which would be prepared by the chiefs of the sections in the Bureau, if such a report were really demanded by the leading members of the Association. As the committee was in doubt as to its powers, no definite plans were made for the continuance of these reviews, and if it is still the desire of the Association to have such published in the JOURNAL OF ECONOMIC ENTOMOLOGY, further consideration should be given to this matter at this meeting.

P. J. PARROTT,
E. L. WORSHAM,
WILMON NEWELL,
A. F. BURGESS,
Committee.

On motion the report was adopted and placed on file.

PRESIDENT P. J. PARROTT: We will now listen to the report of the Employment Bureau by Mr. F. L. Washburn.

REPORT ON THE WORK OF THE EMPLOYMENT BUREAU

January 1, to December 31, 1913

A few remarks on the work of the Bureau may not be out of place at this time. While the work of this last season has increased over that of the previous and initial year of its existence, it has not been arduous. We could not allow it to become so and still do what is called for from us as entomologists, although we have used all effort possible to place our men.

We realize, however, while we feel that the Bureau is really making good and is a promising project, that one could easily devote twice the energy and time to it that we have been able to do, with a corresponding increase, of course, in its efficiency. We were at first, during last year and the first part of the present year, somewhat despondent regarding the success of the undertaking, but recently it has appeared

to be of much more interest than in the beginning and calling to itself more patronage.

While we have had several inquiries, evidently due to the advertisement in the JOURNAL, we have found that we could well supplement this by sending out circular letters to agricultural colleges and stations. Such letters brought quite a few responses and we have had several inquiries in reply and have been instrumental, we believe, in filling at least one of the higher ranking positions with a good man and obtaining positions of minor rank for others.

The enrollment has been characterized by the presence, on the one hand, of a few men of perhaps national and even international reputation. As a rule, however, as we all know, the seasoned workers, those who through ability and experience stand high in the profession, do not make use of any form of agency since they are approached directly by those seeking their services. These men ask salaries ranging from $1,800 as the minimum to $3,000 as the maximum; on the other hand, the Bureau is largely patronized by beginners, some of whom are willing to accept positions as student assistants, offering an income of from $250 to $300. Others want from $500 to $800 as a beginning salary. Then there is, between these two extremes, an intermediate class, of really good men seeking initial salaries of from $1,000 to $1,200. I do not wish to convey the idea, by these statements, that the Bureau has a large enrollment, but the above conditions are represented by even the limited number of names on our books.

You will realize the difficulty experienced by us in trying to fill positions which demand much of a young man, yet offering only salaries which will attract the younger or less experienced entomologists,—salaries very close to the mimimum mentioned above. Again, it is sometimes hard to please the younger men who seek help through our services. There are some who are impatient,—almost insistent that their special applications should be pushed, and critical if no results are obtained,—critical even to the point of asking for their money back. This request for the return of the fee, it must be said, happened in only one instance. We have had, repeatedly, to state to these younger men the object of the Employment Bureau, namely, that it is organized to bring in touch institutions who desire men for entomological work, with entomologists seeking positions and that we make it a rule not to push any one candidate in preference to another.

In at least one instance, it would appear that a candidate who has been placed and yet desires a better paying position looks upon the Bureau as still bound, under the terms of his initial enrollment and payment of fee, to seek to better his position. The Bureau would be very glad to have from the Association, suggestions covering this condition.

In conclusion, we believe that the Employment Bureau has a place in the work of entomologists and that it will make good. It is evident that it requires considerable attention on the part of the one directing the work and, as said before,—the more attention given—the more accomplished. We feel that we have given all the time possible for us to give in this line, and beg leave to present our resignation at this meeting in our capacity as Director of the Bureau.

FINANCIAL STATEMENT

F. L. Washburn

In account with the Employment Bureau, *Dr.*

Cash on hand January 1, 1913	$12.50	
To 13 subscriptions between January 1, 1913, and December 31, 1913, at $2.00	26.00	
		$38.50

Cr.

By four subscriptions (refunded as authorized by Association in January, 1913) at $2.00	$8.00	
By stamps used	4.00	
By stationery used	2.00	
By advertisement in JOURNAL	.25	
		$14.25
Balance, cash on hand		$24.25

F. L. WASHBURN.

Voted that the report be accepted and the recommendations adopted.

PRESIDENT P. J. PARROTT: I will now call for the report of the Committee on Entomological Investigations, by Mr. W. C. O'Kane.

REPORT OF COMMITTEE ON ENTOMOLOGICAL INVESTIGATIONS, 1913–14

Compiled by W. C. O'KANE

Investigations dealing with Mammalia

Nebraska, Lincoln,—Myron H. Swenk.

The prairie-dog.

Substantial progress. Preliminary publication contemplated.

New Mexico, State College,—D. E. Merrill.

Prairie-dogs.

Collecting data as to distribution, numbers, and damage, looking toward efforts at control.

Rodents.

Tests of poisons, traps, etc. Scattering.

Investigations dealing with Crustacea

Mississippi, Agricultural College,—R. W. Harned, R. N. Lobdell.

The crayfish of Mississippi.

Slight progress during the past year.

Investigations dealing with Acarina

Montana, Bozeman,—R. A. Cooley.

Tick investigations in Montana with particular reference to *Dermacentor venustus.*

North Carolina, Raleigh,—Franklin Sherman, Jr.

Red spider on cotton,—C. L. Metcalf, Assistant.

Observations on life history, habits, etc. Begun last year; will continue.

New York, Geneva,—P. J. Parrott.

Monographic study of the *Eriophyidæ* of New York. In immediate charge of H. E. Hodgkiss.

Ohio, Wooster,—H. A. Gossard.

Mites affecting live stock and poultry. D. C. Mote.

(Dept. Animal Husbandry, in coöperation with Dept. Entomology.)

Treatment of mites affecting stored products and greenhouse plants.

Experiments by Goodwin, Gossard and Whitmarsh.

Oregon, Corvallis,—H. F. Wilson.
The red spider mites of Oregon.

Tennessee, Knoxville,—E. C. Cotton.
North American fever tick.

Investigations dealing with Thysanoptera

Connecticut, New Haven,—W. E. Britton.
Control of onion thrips.
Beginning made.

Florida, Gainesville,—J. R. Watson.
Thrips on tomatoes.

Massachusetts, Amherst,—H. T. Fernald.
Methods for the control of onion thrips on large fields.
Work completed.

New Mexico, State College,—D. E. Merrill.
Onion thrips.
Very little was done this last year on account of shortage of funds.

New York, Cornell University, Ithaca,—Glenn W. Herrick.
An investigation of onion thrips in New York. J. C. Faure in charge.
The work is completed.

New York, Geneva,—P. J. Parrott.
The life history, habits and distribution in New York of the pear thrips, *Euthrips pyri*.

Investigations dealing with Mallophaga and Anoplura

California, Stanford University,—V. L. Kellogg.
Preparation of complete mammalian host list (with distribution of the hosts) of the known Mallophaga and Anoplura, with study of the significance of the host and geographic distribution of the parasites.
The host list completed: the study under way.
(with S. Nakayama). Comparative morphology of the Mallophaga and Anoplura, and the taxonomic study of collections from mammals of California, birds of Antarctic Ocean, Scotland, England, etc.
Work well under way.

New York, Cornell University, Ithaca,—Glenn W. Herrick.
The Mallophaga of domestic fowls.

Investigations dealing with Orthoptera

Kansas, Manhattan,—Geo. A. Dean.
Habits and life history of injurious grasshoppers, together with methods of control. Geo. A. Dean.
Parasitic and predaceous enemies of grasshoppers, Paul S. Welch.

Nebraska, Lincoln,—Myron H. Swenk.
Grasshopper control. Lawrence Bruner in charge.
Substantial progress.

New Mexico, State College,—D. E. Merrill.
Grasshoppers.
Experiments made with hopperdozer looking toward its use in irrigated fields. Also furthered the investigations into habits of the damaging species of grasshoppers.

New York, Geneva,—P. J. Parrott, B. B. Fulton.
Life histories, habits and means of controlling the tree crickets, *O niveus* and related species.

Ohio, Wooster,—H. A. Gossard.
Survey of Orthoptera of Wayne County, Ohio, and incidentally of Ohio, as opportunity offers. Life history and economic control studies.

Washington, Pullman,—A. L. Melander.
Grasshoppers.
An unusual outbreak in Eastern Washington was studied this fall.

Investigations dealing with Hemiptera

Arizona, Phoenix,—A. W. Morrill.
Miscellaneous aphis investigations—Control of the several aphis pests in field and garden.
Preliminary work. O. C. Bartlett in charge.

Arkansas, Fayetteville,—George G. Becker.
(I) The supposed immunity of Northern Spy stock to the attacks of woolly aphis.
(II) Studies of the relationship of woolly aphis to its various hosts.
Substantial progress.

Canada, Guelph,—Lawson Caesar.
Capsids and closely allied insects attacking apples.
San José scale, its distribution in Ontario, and control measures, especially in old orchards.
Completed, bulletin soon ready for press.

Colorado, Fort Collins,—C. P. Gillette.
Life histories, food plants and remedies for the plant lice of Colorado.
Life history and methods of controlling the tomato psyllid. S. Arthur Johnson in immediate charge.

Connecticut, New Haven,—W. E. Britton.
Control of pea aphis by spraying.

Florida, Gainesville,—J. R. Watson.
White fly studies.

Illinois, Urbana,—S. A. Forbes.
Tests on a large scale of improved metods of individual and community operation against outbreaks of the chinch bug.

Iowa, Ames,—R. L. Webster.
Oyster shell scale, *Lepidosaphes ulmi.*

Kansas, Manhattan,—Geo. A. Dean.
Chinch bug control, Geo. A. Dean and J. W. McColloch.
Chinch bug egg parasite, J. W. McColloch.
Control of San José scale, J. H. Merrill.

Maine, Orono,—Edith M. Patch.
Ecological and morphological investigations of Aphididæ.
Ecological and morphological investigations of Psyllidæ.

Minnesota, St. Anthony Park,—F. L. Washburn.
Minnesota scale insects. W. Moore in immediate charge.

Mississippi, Agricultural College,—R. W. Harned, E. W. Stafford.
Scale insects of Mississippi (food habits and life history of the native species).
Some progress.

Missouri, Columbia,—Leonard Haseman.
The tarnished plant bug and its work on peach and other plants.
Well under way.
The apple leaf hopper.
Well under way.
The distribution of the various broods of the Periodical Cicada occurring in Missouri.
Reports completed this season.
The control of San José scale.
Just beginning a systematic campaign for the control of this pest throughout the state in connection with the enforcement of the recently enacted Nursery and Orchard Inspection Law.

Montana, Bozeman,—R. A. Cooley.
Life history and control of the sugar beet louse (*Pemphigus betæ*).
Study of the control of the oyster shell scale by use of insecticides.

New York, Geneva,—P. J. Parrott, H. E. Hodgkiss.
Life history, habits and means of protecting pear orchards from the false tarnished plant-bug, *Lygus invitus* Say.
A study of the activities of the late summer broods of the Pear Psylla and finding of more efficient means of control.
The life history, habits and means of controlling the grape leaf hopper. F. Z. Hartzel in immediate charge.

New Mexico, State College,—D. E. Merrill.
The grape leaf hopper.
Experiments as to control in the vineyard; detailed life history. Probably will finish next season.
San José scale.
Some summer spraying to test effectiveness.

North Carolina, Raleigh,—Franklin Sherman, Jr.
Laundry soap in water as a remedey for aphids.
This project will be continued. It is believed that simple solutions of this material are preferable to the more complex emulsions, more available than tobacco extracts, and just as satisfactory,—hence to be recommended, especially for small-scale operations, as in gardens, etc.

North Carolina, West Raleigh,—Z. P. Metcalf.

Life history and methods of controlling the gloomy scale, *Chrysomphalus tenebricosus* Comst.

In progress.

Ohio, Wooster, —H. A. Gossard.

Life history and economic control studies of Ohio *Pentatomidæ*.

Life histories of several species practically completed. R. D. Whitmarsh.

Ohio *Coccidæ*. General state survey

Several new records for the state. Control measures especially for species affecting shade and ornamental trees. J. S. Houser.

Lice affecting live stock and poultry and control measures. D. C. Mote. (Dept. Animal Husbandry in cooperation with Dept. Entomology).

Apple root louse. Control, etc. J. S. Houser.

Peru, S. A., Lima,—Charles H. T. Townsend.

Under the supervision of Dr. Townsend, Mr. E. W. Rust has mounted and identified a large proportion of the Coccid material gathered during the past four years in Peru. Peruvian parasites of *Saissetia* have been sent to the California State Insectary, arriving there alive and in good condition.

White Scale of cotton (*Hemichionaspis minor*) and its parasites.

Coccids and microhymenopterous parasites of the same in Peru.

Tennessee, Knoxville,—E. C. Cotton.

The hog louse.

Virginia, Norfolk,—T. C. Johnson.

Life history of the spinach aphis. Cabbage aphis. Pea aphis. Cucumber aphis.	In charge of F. H. Chittenden.

Washington, Pullman,—A. L. Melander.

Viability of the San José scale in different districts of the State, using identical insecticides and determining the period lapsing before death.

Last spring over 300,000 scales were examined.

West Virginia, Morgantown,—W. E. Rumsey.

The control of the apple tree aphis through the destruction of its eggs.

Lime-sulfur proved better than any other substance tried. Will be continued another season.

The control of the woolly aphis.

Not yet begun.

Wisconsin, Madison,—J. G. Sanders.

Life history studies of the apple aphids in Wisconsin.

Investigations dealing with Lepidoptera

Arkansas, Fayetteville,—George G. Becker.

Life history and methods of control of *Sanninoidea exitiosa*.

Substantial progress.

Arizona, Phoenix,—A. W. Morrill.
Life history and control of the codling moth under the widely varying conditions found in Arizona.
Banding and other records continued.

Colorado, Fort Collins,—C. P. Gillette.
Life history and better measures of controlling the codling moth in Colorado.
Fruit-tree leaf roller investigations. George P. Weldon in immediate charge.

Connecticut, New Haven,—W. E. Britton.
Life history of a leaf roller, *Archips rosana* Linn., attacking privet hedges.
Completed and being prepared for publication. B. H. Walden.

Connecticut, Storrs,—G. H. Lamson.
The use of hogs in controlling the codling moth in apple orchards.

Florida, Gainesville,—J. R. Watson.
Heliothis obsoleta on tomatoes.
The life history and control of *Anticarsia gemmatilis* Hbn. on velvet beans.

Indiana, Lafayette,—James Troop.
The life history of the colding moth for northern, central and southern Indiana.
Number of broods of the fall army worm in north and south ends of the State of Indiana.

Kansas, Manhattan,—Geo. A. Dean.
Life history and measures of controlling the corn ear worm. J. W. McColloch.

Minnesota, St. Anthony Park,—F. L. Washburn.
Spraying investigations. A. G. Ruggles in immediate charge.

Missouri, Columbia,—Leonard Haseman.
The unspotted tentiform leaf miner of the apple.
Ready to report.
Peach tree borer.
Just begun.

Montana, Bozeman,—R. A. Cooley.
Life histories and means of controlling the cutworms of Montana.

Nebraska, Lincoln,—Myron H. Swenk.
Cutworm injury to Nebraska crops.
Considerable data accumulated.

New Mexico, State College, D. E. Merrill.
Peach worm (*Anarsia lineatella*).
Work on life history here fairly complete; will finish that this year and try various control measures.

New York, Geneva,—P. J. Parrott.
The life history, habits and distribution of the apple and cherry ermine moths.

New York, Albany,—E. P. Felt.
A study of the efficiency of spraying for the control of the codling moth.
In the Hudson Valley under normal crop conditions one thorough application results in 95–98 per cent of worm-free fruit.

New York, Cornell University, Ithaca,—Glenn W. Herrick.

Further experiments in the control of the fruit-tree leaf-roller.

This will consist mainly of a series of coöperative experiments.

Life history and control of the codling moth in western New York. R. W. Braucher in charge.

The work on the life history is practically completed.

The canker worms of New York. F. W. Pettey in charge.

The work has just been begun.

North Carolina, West Raleigh,—Z. P. Metcalf.

Investigations of the imported cabbage web worm, *Hellula undalis* Fabr.

In progress.

Ohio, Wooster,—H. A. Gossard.

The two species of peach borers in the Lake Erie fruit district. Life history studies and control measures. Codling worm and lesser apple worm in same district. J. L. King.

Clover leaf roller. Life history and control measures. H. A. Gossard.

Grape berry worm. Life history and control measures. W. H. Goodwin.

Tennessee, Knoxville,—E. C. Cotton.

Peach tree borer.

Utah, Logan,—E. G. Titus.

Life history of the codling moth.

Washington, Pullman,—A. L. Melander.

Vanessa californica.

This insect appeared in excessive numbers last season from British Columbia to California.

Investigations dealing with Diptera

Canada, Guelph,—Lawson Caesar.

Life history, distribution and control of the apple maggot, *Rhagoletis pomonella.*

Almost completed.

Life history, distribution and control of the cherry fruit flies, *Rhagoletis cingulata* and *R. fausta*.

Almost completed.

Connecticut, Storrs,—G. H. Lamson.

The use of hogs in controlling the apple maggot.

Connecticut, New Haven,—W. E. Britton.

The control of the mosquito nuisance in Connecticut and the effect of drainage on the salt marsh flora and yield.

Some progress has been made, but observations must necessarily extend over a period of several years.

Control of cabbage maggot.

Field tests have been made and will be continued.

Indiana, Lafayette,—James Troop.

The life history of the Hessian fly in northern, central and southern Indiana.

Illinois, Urbana,—S. A. Forbes.
The occurrence and life history of the black flies of Illinois with particular reference to the possibility of these insects serving as agents in the transmission of pellagra.

Kansas, Manhattan,—Geo. A. Dean.
Life history and measures of controlling the Hessian fly. Geo. A. Dean and J. W. McColloch.

Massachusetts, Amherst,—H. T. Fernald.
Methods for the control of onion maggot on large fields.
Progress satisfactory.

Minnesota, St. Anthony Park,—F. L. Washburn.
Problems in connection with the Muscid flies, *Simulidæ* and *Culicidæ*.
C. W. Howard in immediate charge.
The wheat stem maggot, *Meromyza americana*, C. W. Howard and Warren Williamson in immediate charge.

New Hampshire, Durham,—W. C. O'Kane, C. H. Hadley, Jr.
The apple maggot.
Will be published this winter.
The control of root maggots by the use of insecticides.
Two seasons of preliminary work completed.
The control of black flies, deer flies and midges.
In progress.

New York, Albany,—E. P. Felt.
A monographic study of the biology and the taxonomy of the gall midges.
Well along, largely in manuscript.

New York, Geneva,—P. J. Parrott.
The life history, habits and means of controlling the grape midge. F. Z. Hartzell in immediate charge.
Life history and habits of the Hessian fly (in coöperation with the U. S. Bureau of Entomology).
The life history, habits and methods of control of the cabbage maggot. This involves a special study of the reaction of the puparia to heat and desiccation, and of the methods of protecting seed beds.

Ohio, Wooster, —H. A. Gossard.
Various species of onion maggots. Control measures. J. S. Houser.

Peru, S. A., Lima,—Charles H. T. Townsend.
Muscoid fly reproduction investigations.
A very considerable amount of muscoid dissection work has been accomplished, including male as well as female reproductive systems and important results have thereby been secured, which will be published in due course.

Washington, Pullman,—A. L. Melander.
Habits and methods of control of root maggots.
Napthalene was found to give protection.

Wisconsin, Madison,—J. G. Sanders.
The onion maggot and its control.
Other onion insects are being investigated along with this work.

Investigations dealing with Coleoptera

Alabama, Auburn,—W. E. Hinds.

The life history and control of the rice or black weevil, *Calandra oryza*.

Substantial progress.

Arizona, Phoenix,—A. W. Morrill.

Experiments in the control by means of arsenicals of the "corrupted lady bird" on beans, *Epilachna corrupta*.

Comparative life history studies at different elevations within the range of the insect added to the original plan.

Green fruit beetle (*Allorhina mutabilis*) life history, habits and control.

Good progress with studies of life history and habits. Satisfactory control methods not yet demonstrated.

Arkansas, Fayetteville,—George G. Becker.

Life history, habits and methods of control of *Saperda candida*.

This is really two projects: (1) life history and habits, (2) the measures of control. Substantial progress.

Australia, Brisbane, Queensland,—A. A. Girault.

Investigations of the sugar cane grubs (Scarabeids in general) of Australia.

Colorado, Fort Collins,—C. P. Gillette.

The life history and practicable means of controlling *Epilachna corrupta* Muls. S. Arthur Johnson in immediate charge.

Connecticut, New Haven,—W. E. Britton.

The life history, damage and control of the white pine weevil in Connecticut.

A beginning made. Studies must reach over a period of several years.

Illinois, Urbana,—S. A. Forbes.

Life history of the species of Lachnosterna (white grubs), the conditions bringing on outbreaks, and the practical use of insect and plant parasites in their control.

Louisiana, Baton Rouge,—E. S. Tucker.

A study of *Diabrotica 12-punctata*, particularly in the larval stage, when it is called the southern corn rootworm or drillworm.

The object is to learn particulars that will be an addition to our knowledge of the species. Through complaints of damaged potato tubers, a new habit of the larva has been discovered which makes it an enemy of the potato crops in our wet lands.

Massachusetts, Amherst,—H. T. Fernald.

Methods for the control of wireworms. Completed.

Minnesota, St. Anthony Park,—O. G. Babcock.

Corn bill bug.

Missouri, Columbia,—Leonard Haseman.

The hickory twig girdler. Ready to report.

The striped cucumber beetle. Just begun.

The clover leaf weevil. Just begun.

Elm tree borer. T. J. Talbert and L. Haseman in charge. Work just begun.

Montana, Bozeman,—R. A. Cooley.
Life history and control of the sugar beet silphid (*Silpha bituberosa*).

New Mexico, State College,—D. E. Merrill.
Bean lady beetle (*Epilachna corrupta*).
Experiments to find strength of arsenical and kind to be effective and not injure foliage.

New York, Geneva,—P. J. Parrott.
The life history and methods of controlling the rose chafer. F. Z. Hartzell in immediate charge.
The life history, habits and methods of controlling the grape root worm. F. Z. Hartzell in immediate charge.

North Carolina, Raleigh,—Franklin Sherman, Jr.
Potato flea-beetle and control,—C. L. Metcalf, Assistant.
Spraying tests to control this, along with other potato insects and diseases, with observations on (a) effect on flea-beetle injuries,—(b) effect on yield. Begun this year,—will continue.

North Carolina, West Raleigh,—Z. P. Metcalf.
Biological investigations of *Sphenophorus callosus* and other injurious members of this genus occurring in North Carolina.
Practically completed.
An investigation of the life history and methods of control of the cow pea weevil, *Pachymerus chinensis* L.

Ohio, Wooster,—H. A. Gossard.
Bark beetles. Life history and control studies. H. A. Gossard and J. L. King.
White grubs. Control measures. H. A. Gossard and J. S. Houser.
Various species affecting stored grains and products. Control measures. W. H. Goodwin.
Life history studies of *Balaninæ* or nut weevils. W. H. Goodwin.

Oregon, Corvallis,—H. F. Wilson.
The *Scolytidæ* infesting the Douglas fir.

Utah, Logan,—E. G. Titus.
The life history of the alfalfa weevil.

Virginia, Norfolk,—T. C. Johnson.
The bean weevil.
The Colorado potato beetle.
} F. H. Chittenden in immediate charge.

Washington, Pullman, —A. L. Melander.
Distribution and control of the Colorado potato beetle.
This new-comer to Washington is spreading rapidly.
Taxonomy of the *Agromyzidæ*. Published in Jour. N. Y. Ent. Soc.

Investigations dealing with Hymenoptera

Arizona, Phoenix,—A. W. Morrill.
Ant control, *Pogonomyrmex barbata*
Additional work planned—satisfactory conclusions not reached.
Control of alfalfa seed chalcis fly (*Brucophagus funebris*).
Preliminary field experiments unsatisfactory but give a useful basis for future work.

Colorado, University of, Boulder,—T. D. A. Cockerell.
Bees (*Apoidea*) of the world.

Illinois, Urbana,—A. D. MacGillivray.
The classification of the larvæ of the *Tenthredinoidea.*

Iowa, Ames,—R. L. Webster.
Two species of strawberry slugs, *Empria maculata* and *Empria* sp.
Investigations practically completed.

Maryland, College Park,—A. B. Gahan.
Classification and host relations of the *Braconidae,* sub-family *Opiinæ.*

Massachusetts, East Wareham,—H. J. Franklin.
Bumblebees.
Monograph on bumblebees of the New World published.

Minnesota, St. Anthony Park,—F. L. Washburn.
Clover-seed chalcid, *Brucophagus funebris.* Warren Williamson in immediate charge.
Larch saw fly. A. G. Ruggles in immediate charge.
Isosoma spp. Warren Williamson in immediate charge.
Minnesota *Hymenoptera.* F. L. Washburn in immediate charge.

Missouri, Columbia,—L. Haseman.
A study of bee keeping in Missouri with special reference to breeding habits. Work just begun.

New York, Geneva,—P. J. Parrott, B. B. Fulton.
Life history, habits and methods of controlling the cherry saw fly leaf miner, *Profenusa collaris* MacG.
Distribution, life history and methods of controlling *Polydrosus impressifrons.* W. J. Schoene in immediate charge.

Utah, Logan,—E. G. Titus.
The life history of the wheat straw worm.

Washington, Pullman,—A. L. Melander.
Effects of endoparasitic Hymenoptera on the host insect. A histologic study.

Wisconsin, Madison,—J. G. Sanders.
Wisconsin bee-keeping conditions.

Investigations dealing with groups of insects or with insecticides or with both

Alabama, Auburn,—W. E. Hinds.
Carbon bisulphide and hydrocyanic acid gas as insecticides.
Substantial progress.
An investigation of the factors affecting the distribution, adhesion, economy of application and insecticidal efficiency of arsenical insecticides with particular reference to arsenate of lead in its various forms.

In a general way results so far show that there is apparently a considerable shedding of fruit on sprayed trees due to arsenical effect and not to any insect injury. Further work will be done along this line and it is believed that it will develop something of material value for the consideration of orchard sprayers

and possibly for all users of arsenical insecticides. It is hoped through this project to be able to standardize arsenate of lead both for the manufacturer and for the sprayer.

California, Stanford University,—V. L. Kellogg.
The influence of age of sperm and egg cells on sex of young in silkworms.
Seven hundred and fifty controlled matings made: egg clutches awaiting rearing.

Colorado, Fort Collins,—C. P. Gillette.
Insect control through treatment of their eggs.

Colorado, University of, Boulder,—Theo. D. A. Cockerell.
Insect fauna of Colorado.
Fossil insects.

Connecticut, New Haven,—W. E. Britton.
Insects attacking vegetable crops in Connecticut.
Insects attacking the white pine in Connecticut.
Insects attacking peach in Connecticut.

Connecticut, Storrs,—G. H. Lamson.
Insects that attack cucurbits.
Insects that attack peach.

Iowa, Ames,—R. L. Webster.
Potato insects. Investigations practically completed.

Kansas, Manhattan,—Geo. A. Dean.
Relation of climate to injurious insects, Geo. A. Dean and J. W. McColloch.
Measures of controlling mill and stored grain insects, Geo. A. Dean.

Louisiana, Baton Rouge,—E. S. Tucker.
Insects affecting stored rice.
Progress has been made in determining the life history of the principal species and their resistance to fumigating agents under warehouse conditions.

Massachusetts, Amherst,—H. T. Fernald.
A study of the causes producing the burning of foliage by insecticides. Progress satisfactory.
Investigations of the real amount of benefit obtained by the work of the different groups of parasites. Progress satisfactory.
Distribution limits of pests in Massachusetts. Progress satisfactory.
Strength of fumigation safe on different greenhouse crops as compared with strength necessary for destruction of the pests. Temporarily discontinued. Will be resumed fall of 1914.

Massachusetts, East Wareham,—H. J. Franklin.
Cranberry insects (injurious and beneficial).
Progress fully reported in last three annual reports of the Cape Cod Cranberry Growers' Association, and in the last two annual reports of Massachusetts Agricultural Experiment Station.

Michigan, East Lansing,—R. H. Pettit.
How contact insecticides kill. E. G. Shafer in immediate charge.
The life histories and control of various fruit and field crop insects.
The life histories and control of insects injurious to Michigan forests.

Minnesota, St. Anthony Park,—F. L. Washburn.
Shade tree pests. A. G. Ruggles in immediate charge.

Mississippi, Agricultural College,—R. W. Harned.
Insects affecting pecans (mainly life history studies). Some progress.

Missouri, Columbia,—L. Haseman.
The insect pests attacking nursery stock in Missouri. T. J Talbot in charge.
This work is just begun, and will extend over a series of years.

Nebraska, Lincoln,—Myron H. Swenk.
The rôle of insects in tripping alfalfa blossoms and the subsequent effect of such tripping on the size of the seed crop.
Progress satisfactory. Preliminary publication contemplated.
A monographic account of the insect enemies of alfalfa. Progress satisfactory.

New Hampshire, Durham,—W. C. O'Kane, C. H. Hadley, Jr.
Insect outbreaks.
A determination of the amount of arsenic left on fruit, foliage and grass following application of sprays. Substantial progress.
Distribution and food plants of New Hampshire insects. Conducted as continuous work.
Dust spraying. Comparative efficiency and cost of dry and wet applications.

New York, Albany,—E. P. Felt.
Shade and forest tree insects.
Numerous insects belonging in this group have been studied and reported upon each year.
The effect of applications of petroleum or petroleum compounds to dormant trees.
This investigation has extended over three years and some very conclusive data secured.
Factors influencing the distribution and abundance of insects.
Considerable data have been accumulated though not much has been published except incidentally with other studies.

New York, Cornell University, Ithaca,—Glenn W. Herrick.
Insects injurious to hops in New York. I. M. Hawley in charge.
The work has just been begun.

North Carolina, Raleigh,—Franklin Sherman, Jr.
Pecan insects, C. L. Metcalf, Assistant.
A study of the species affecting this tree, with observations on habits, life-histories, and control measures of those that are serious. Begun this year.

Ohio, Wooster,—H. A. Gossard.
Insects affecting stored grains and stored products with methods of control. W. H. Goodwin.
Insects affecting shade and ornamental trees with questions relating to organization of city and park treatment from standpoint of economy—in other words, best methods of municipal control. J. S. Houser.

Control of insects affecting live stock. D. C. Mote (Dept. Animal Husbandry in coöperation with Dept. Entomology).
Moisture as a factor in treatment of insects by the heat method. W. H. Goodwin.
The time factor in treatment of summer insects. In connection with preparation of Summer Manual of Practice in Economic Zoölogy. H. A. Gossard.
Spraying machinery and accessories. W. H. Goodwin.

Oregon, Corvallis,—H. F. Wilson.
Investigations of insecticides and combination sprays.
This includes lime-sulphur, arsenate of lead, arsenite of zinc, soluble sulphur, atomic sulphur, etc., and a few miscellaneous investigations of minor importance.

Pennsylvania, Harrisburg,—H. A. Surface.
Susceptibility of varieties of cultivated plants, especially fruits, to insect and plant-disease injury.
Improvement of the lime-sulphur solution.
Prevention of peach tree borer and certain other orchard pests.

Peru, S. A., Lima,—Charles H. T. Townsend.
Transmission of verruga by bloodsuckers.
These investigations have been carried on by the entomologist personally, assisted by Mr. E. W. Rust, from May to July and by Mr. G. E. Nicholson since July. The result is the complete demonstration, through transmission experiments, of *Phlebotomus verrucarum* Towns, as the vector of verruga. About 50 species of bloodsuckers have been found to exist in the verruga zones so far, of which the *Phlebotomus* proves to be the only strictly nocturnal and crepuscular species confined to these zones. The other species are being worked up by specialists. The early stages of the *Phlebotomus* have not yet been found, despite repeated search.

Porto Rico, Rio Piedras,—
General entomological survey of the sugar cane areas of Porto Rico.
Outlined in last year's report.
General breeding work.
Laboratory and office work.
Field work.
Experimental work. Outlined in last year's report.

Utah, Logan,—E. G. Titus.
Arsenical poisoning of fruit trees.

West Virginia, Morgantown,—W. E. Rumsey.
The control of the apple and peach tree borers.
Progress satisfactory.

Washington, Pullman,—A. L. Melander.
Effect of oil sprays on fruit trees.

Taxonomic Directory

Thysanoptera.
W. E. Hinds, Auburn, Ala., will classify for privilege of retaining duplicates and of naming and describing the new species.
Mallophaga and *Anoplura.*
V. L. Kellogg, Stanford University, Cal., will classify collections (under reservation

as to available time) for usual privileges; especially glad to examine material from mammals.

Orthoptera.

R. A. Cooley, Bozeman, Mont., will classify *Orthoptera* of the Northwest.

B. H. Walden, New Haven, Conn., will classify, in so far as other work will permit.

Membracidæ, Jassidæ, Cercopidæ and *Fulgoridæ.*

Z. P. Metcalf, West Raliegh, N. C., will classify for permission to retain new and unusual forms for further study, and to dispose of a fair number of such forms as he may see fit.

Jassidæ.

E. D. Ball, Logan, Utah, will classify North American forms under the usual conditions.

Aphididæ.

C. P. Gillette, Fort Collins, Colo., will classify, provided data on food plants and date and location of capture are furnished, and the privilege of retaining the specimens of special interest when there are duplicates.

H. F. Wilson, Corvallis, Oregon, will classify *Aphididæ* if data on food plants, dates and location of capture are furnished. The correct scientific name of the food plant should be given.

Aphididæ and *Psyllidæ.*

Edith M. Patch, Orono, Maine, will classify on receipt of mature material in good condition with record of food plant accurately determined on which the species developed.

Aleyrodidæ.

J. R. Watson, Gainesville, Fla.

Coccidæ and *Aleyrodidæ.*

W. E. Britton, New Haven, Conn., will classify in so far as other work will permit.

Coccidæ.

J. G. Sanders, Madison, Wis., will classify species of the genus *Lecanium.*

R. A. Cooley, Bozeman, Mont., will classify the genera *Chionaspis, Hemichionaspis* amd *Phenacaspis* of the world.

R. H. Pettit, East Lansing, Mich., will classify in so far as other work will permit.

Heteroptera.

Paul S. Welch, Manhattan, Kansas, will classify, in so far as other work will permit, Aquatic *Heteroptera.*

Sarcophagidæ of the Northeastern U. S., *Trypetidæ,* if sent before May 1, 1914.

H. T. Fernald, Amherst, Mass., will classify.

Chironomidæ and *Mycetophilidæ.*

O. A. Johannsen, Cornell University, Ithaca, N. Y., will classify for the privilege of retaining desiderata.

Muscoid flies.

Charles H. T. Townsend, Lima, Peru, S. A., will classify as time permits. Will send names in return for specimens.

Empididæ.

A. L. Melander, Pullman, Wash. (at the Bussey Institution, Forest Hills, Boston, Mass., until June), will determine *Empididæ* (Diptera) for the privilege of retaining desiderata.

Syrphidæ.

A. L. Lovett, Corvallis, Oregon, will determine if duplicates are sent.

Itonididæ.

E. P. Felt, State Museum, Albany, N. Y., will classify provided the midges are new, from new localities or have been reared and food record is available.

Megastigmus.

C. R. Crosby, Cornell University, Ithaca, N. Y.

Chalcidoidea.

A. A. Girault, Brisbane, Queensland, Australia, will classify.

Bombidæ.

H. J. Franklin, East Wareham, Mass., will classify to limit of his spare time.

Tenthredinidæ and *Uroceridæ.*

A. D. MacGillivray, 603 W. Michigan Ave., Urbana, Ill., will classify in so far as other work will permit for permission to retain types and specimens not present in collection.

Aphidiinæ and *Opiinæ*, sub-families of *Braconidæ.*

A. B. Gahan, College Park, Md., will classify on condition that specimens may be retained if desired.

Sphecidæ, Elidinæ, Aporinæ, genus *Ichneumon* of N. E.; also genus *Xylocopa* if sent before May 1, 1914.

H. T. Fernald, Amherst, Mass., will classify.

Ichneumonidæ.

J. H. Merrill, Manhattan, Kansas, will classify, in so far as other work will permit, *Rhyssides* of the *Ichneumonidæ.*

Apoidea.

E. G. Titus, Logan, Utah. For permission to retain types and specimens not present in his collection.

Myron H. Swenk, Lincoln, Neb., will classify members of this group from Nebraska, and any North American member of the following genera—*Colletes, Nomada* and *Anthidium.*

Nymphulinæ.

Paul S. Welch, Manhattan, Kansas, will classify in so far as other work will permit, the family *Nymphulinae.*

By vote of the Association the report was received.

PRESIDENT P. J. PARROTT: The next order of business will be the report of the Committee on Incorporation, by Mr. E. P. Felt.

REPORT OF COMMITTEE ON INCORPORATION

Acting under the authorization given the committee at the last annual meeting, the Association has been incorporated as shown by the following articles of incorporation:

ARTICLES OF INCORPORATION

CITY OF WASHINGTON, DISTRICT OF COLUMBIA:

We, the undersigned
P. J. Parrott, Geneva, N. Y.
W. D. Hunter, Washington, D. C.,
A. L. Quaintance, Washington, D. C.

being persons of full age and citizens of the United States, and a majority being citizens of the District of Columbia, pursuant to and in conformity with Sections 599–604 of the Code of Law for the District of Columbia, enacted by the Senate and House of Representatives of the United States of America in Congress assembled and approved March 3, 1901, hereby associate ourselves together as a body corporate, and certify in writing:

1. That the name of the body corporate is the AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS.

2. That the term for which the Association is organized is perpetual.

3. That the particular business and objects of the Association are to promote the science of economic entomology, to stimulate and coördinate the efforts of AMERICAN ENTOMOLOGISTS and (1) to discuss new discoveries, to exchange experiences, and to carefully consider and promote the best methods of work in economic entomology; (2) to give opportunity to individual workers of announcing proposed investigations so as to bring out suggestions and avoid unnecessary duplication of work; (3) to suggest and encourage, when possible, certain lines of investigation upon subjects of general interest within the scope of this association; (4) to promote the study and advance the science of entomology and (5) to publish and encourage the publication of matter pertaining to entomology.

4. That the affairs, funds and property of the Association shall be in general charge of an executive committee consisting of the President, three Vice-Presidents and the Secretary-Treasurer, all of whom shall be elected from members of the Association.

Witness our hands and seals,

WITNESS:
E. PORTER FELT
as to all

PERCIVAL J. PARROTT (Seal)
WALTER D. HUNTER (Seal)
ALTUS L. QUAINTANCE (Seal)

DISTRICT OF COLUMBIA, SS:

I, W. Spencer Armstrong, a Notary Public, in and for the District of Columbia, do hereby certify that Percival J. Parrott, Walter D. Hunter and Altus L. Quaintance, personally well known to be the persons who signed the foregoing and annexed certificate of incorporation of the AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS, personally appeared before me in said District, this 29th day of December, 1913, and acknowledged the same to be their act and deed.

WITNESS my hand and seal this 29th day of December, 1913.

W. SPENCER ARMSTRONG,
Notary Public, Dist. of Col.

(NOTARIAL SEAL.)

Office of Recorder of Deeds,
District of Columbia.

THIS IS TO CERTIFY that the foregoing is a true and verified copy of the Certificate of Incorporation of the AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS as filed in this office the 29th day of December, 1913.

IN TESTIMONY WHEREOF, I have hereunto set my hand and affixed the seal of this office this 29th day of December, A. D. 1913.

R. W. DUTTON,
Deputy Recorder of Deeds, D.C.

(RECORDER'S SEAL.)

A tentative organization was formed at Washington and the following business transacted:

MINUTES OF PRELIMINARY MEETING

A meeting was held at Washington, D. C., December 29, 1913, by Messrs. Parrott, Hunter and Quaintance, signers of the Articles of Incorporation of the American Association of Economic Entomologists, Incorporated.

A temporary organization was effected with A. L. Quaintance, Chairman, and P. J. Parrott, Secretary.

Moved, that the constitution and by-laws with pending amendements, of the American Association of Economic Entomologists as now standing, be adopted. Carried.

Moved, that the present members of the American Association of Economic Entomologists be elected members of the corporation with their present rights and privileges. Carried.

Moved that the meeting adjourn, to assemble at Atlanta, Ga., December 31, 1913.

P. J. PARROTT, *Secretary.*

The committee would call attention to the fact that as a membership corporation we may hold and convey real and personal estate necessary for the purposes of the society as stated in the certificate and other real and personal property. the clear annual income from which shall not exceed in value twenty-five thousand dollars.

Respectfully submitted

E. P. FELT,
A. F. BURGESS,
W. C. O'KANE,
Committee.

PRESIDENT P. J. PARROTT: I am sure that the Association is very much indebted to Doctor Felt for the time and careful attention he has given to this matter and especially for the favorable terms and conditions under which the incorporation was affected. This is a very important matter and it would seem proper to me to discuss the report at this time.

MR. GLENN W. HERRICK: Under this incorporation what is the liability of each member of the Association? I would like to hear that discussed.

MR. E. P. FELT: I don't know that I can answer that fully. A membership corporation does not give as much protection to the

members as a stock corporation, but we were unable to find any state where we could secure incorporation as a stock company without being obliged to have a resident director or hold annual meetings there, or be subject to other restrictions, and it seemed desirable for us to incorporate as a national organization. In regard to the liability of individual members, the legal adviser of the Department of Education at Albany, N. Y., told me that in general the officers of a membership corporation were liable for bills incurred and the members were liable to the officers so far as the officers were able to enforce the same. This is not very definite, but it simply emphasizes the need of putting in office parties who will not involve the membership too deeply. Although this is not an ideal form of incorporation, it seemed to be the most satisfactory solution to the problem. It gives us a legal standing and we can go ahead and do business on a much more satisfactory basis than we could before.

Secretary A. F. Burgess: Doctor Felt did not bring out the point that under this form of corporation we can hold meetings anywhere and at any time without restriction and we are not bound to hold meetings in the District of Columbia unless we care to do so.

President P. J. Parrott: I would suggest that Doctor Felt give us a statement of the advantages which will be secured to the Association as an incorporated body.

Mr. E. P. Felt: The fact of being a corporate body establishes a legal entity and as such we can do business and are entitled to hold property and to have a seal. Any business transacted under this seal represents the act of the body corporate and not that of any individual. This is the principal advantage. We can hold and convey real estate, and as stated in the latter part of the report, we are limited to holding estate or property not necessary for the purposes of the organization, which has an income of less than $25,000 a year. Incorporation is a financial protection to the managers of the publication. If anything should be published in the Journal which would be subject for legal action it would relieve the officers to some extent, at least, from personal responsibility

Mr. Wilmon Newell: I know some of the difficulties that have been in the way of conducting business of the Association for the past few years, and I think we owe Doctor Felt and his associates many thanks for what they have accomplished. It certainly puts the Association in much better shape than ever before and I move that this report be accepted and adopted.

This motion was duly seconded and carried.

President P. J. Parrott: I will now appoint the following committees:

COMMITTEE ON AUDITING: Mr. J. G. Sanders, Mr. E. C. Cotton.

COMMITTEE ON RESOLUTIONS: Mr. Herbert Osborn, Mr. G. A. Dean, Mr. Wilmon Newell.

COMMITTEE ON NOMINATIONS: Mr. W. D. Hunter, Mr. F. L. Washburn, Mr. R. A. Cooley.

PRESIDENT P. J. PARROTT: Is there anything to be considered under the head of miscellaneous business?

SECRETARY A. F. BURGESS: I would like to say a word in regard to the program. The announcement of the meeting was sent out with a request that titles be in my hands November 12. A considerable number of titles came in late, and as far as possible they have been inserted in the printed program. Much difficulty was experienced in preparing the program so that the JOURNAL could be issued before the middle of December, and it was necessary to add a number of titles to the proof before it was returned to the printer. After the program was in press a number of other titles were received, and as our program is not as crowded as usual, it may be possible for some of these papers to be added before the end of the meeting.

On motion the secretary was directed to use his discretion in inserting these papers in the printed program.

PRESIDENT P. J. PARROTT: I will now call for the report by the Committee on Nomenclature.

MR. HERBERT OSBORN: The committee has no formal report to make this year. We have received no requests concerning nomenclature and we will simply ask that the matter be passed without formal report.

By general consent the statement from the committee was received.

PRESIDENT P. J. PARROTT: I will now call for the report of the Committee on the use of Entomological Publications, by Mr. F. L. Washburn.

REPORT OF THE COMMITTEE ON EFFICIENCY OF ENTOMOLOGICAL PUBLICATIONS

Owing to the distance separating the members of the committee appointed at the last meeting to ascertain the use made by farmers of entomological bulletins, and the relation between the arrangement of bulletin contents and their acceptability to agricultural constituencies, we beg leave to report that it has been impossible for the committee to meet and, therefore, we adopted the plan of conferring by mail, each advising the other members of his program of action, so that each might benefit thereby; and, since conference of the committee at the meeting has also turned out to be an impossibility, we have arranged that each shall report separately upon the information collected, with such comments and recommendations as he feels is warranted. Such a method will, at least, possess the merit of furnishing an untrammeled and unmodified expression of the views of each and it seems to us that definite expression of opinion, or recommendation, by the Association, as to the best form of writing

bulletins, can originate as well and perhaps better, in the Association itself, after a consideration and discussion of our respective reports, than from the committee. You will, therefore, please regard our respective comments and recommendations as individual opinions, entitled to as much, and, perhaps, to very little, if any more, consideration than the opinions of any other three members of the Association; for while we have faithfully endeavored to execute the commission given to us, the practical difficulties of getting the information desired has precluded the possibility of reaching very definite conclusions. Therefore, respectively submitting such information as we were able to collect, and claiming our right to be listened to as individuals in discussing the same, we beg the privilege of throwing the questions pertaining thereto before the Association without any recommendations as a committee.

H. A. Gossard,
R. L. Webster,
F. L. Washburn,
Committee.

Report from Ohio

I have utilized three different methods for getting the information desired by the Association as to the acceptability of Station entomological publications. Assuming that the publications of the Ohio Station may be taken as fairly representative of American entomological publications in general, the data I have collected may possess some little significance; but, each member must decide for himself as to what particular merits or demerits of our publications gain acceptability or unpopularity for them, as he conceives them to rise above or fall below the average standard attained by other institutions.

The first method employed by me to ascertain the attitude of an average farming community was to utilize the services of the Ohio Rural Survey and have a house-to-house canvass made over Knox County, Ohio, the Surveyors making use of the following registration blank:—

Township?........................ County?..........................
Name?............................ Address?.........................

(Mr. H. A. Gossard, entomologist of the Ohio Agricultural Experiment Station at Wooster asks that we get answers to the following questions. The questions as you see we use for house-to-house work. I should think if five farmers in a township were interviewed, it would be satisfactory. [Note by Superintendent of Survey.])

1. Do you read the entomological bulletins of the Experiment Station?
2. Do you preserve them for reference? Do you refer to them as occasion demands?
3. How could these bulletins be improved so as to be more usable?
   a. By a different arrangement of matter?
   b. By more illustrations?
   c. In any other way?

I have no means of knowing how the five farmers per township were selected, as I gave no instructions concerning the method, and did not know until I received the reports that any farmers whatever were being omitted from interview. I presume, therefore, that the farmers were taken at random and that their returns are fairly representative of what would have been obtained from almost any fairly good agricultural locality in the state.

Number of farmers interviewed, 56; number receiving the Station bulletins, 35; not on the mailing list, 21. Out of the 35 on the mailing list, 33 read the entomological bulletins and two do not. Out of the 33 readers, 23 file them for reference, and 22 report that they actually use them as references from time to time. Eleven do

not file them at all, and one of those who does neglects to make any further use of them. Another files away only the ones he thinks he may need in the future. Fifteen are agreed that the bulletins cannot be improved or made more readable by a different arrangement of the subject matter, against three who say the contrary and one who questions if such improvement could not be made. Fourteen think they are amply illustrated, against two who want more pictures and one who is still questioning if we can't do better. Fourteen know of no way by which they can be improved, while one does, and our previous questioner still answers with an interrogation point. The following comments were noted on the blanks: "Fine"; "Very good"; "Make more practical"; "Very good now"; "*Very good*"; "Pretty good as now exist"; "Think good as stand."

My second method was to send out 150 copies of the following letter (given in part below), 50 to names taken at random from the roll of the Ohio State Horticultural Society, 50 taken at random from the roll of the Ohio Corn Breeders' Association, and 50 taken at random from the Station mailing list.

EXCERPT FROM CIRCULAR

"1. Please put a pencil check mark after each of the bulletins in the list hereto appended which you have received during the past six years.

2. Put a second pencil check mark after those you have read throughout.

3. Put a third pencil check mark after those that you have partially read by summary or by skimming through to get the main points.

4. Put a fourth pencil check mark after those numbers you have preserved and still have possession of in your library.

Bulletin	191	Spraying apples.
"	194	The more important insects affecting Ohio shade trees.
"	197	The catalpa midge.
"	198	Spring manual of practice in Economic Zoölogy.
"	202	Raspberry Byturus.
"	216	Spraying machinery.
"	226	The wheat jointworm.
"	232	Spray calendar.
"	233	Fall manual of practice in Economic Zoölogy.
"	234	Flour mill fumigation.
"	248	Spraying machinery accessories.
"	250	Some Ohio birds.
"	253	Insect pests of the household.
Circular	95	Apple spraying in 1908.
"	112	Commercial apple orcharding in Ohio.
"	115	The Chinch Bug.
"	137	Grasshoppers.

5. Are our bulletins sufficiently illustrated with photographs and drawings?

6. Please state briefly on the back of this sheet what you think would most help to make our bulletins readable."

The last 50 names used were doubtless of about the same average quality as those of the 56 men interviewed by the Rural Survey, but the first hundred were undoubtedly of a higher average quality, and represented, to a considerable extent, the leadership in Ohio agriculture. At first, I was inclined to suppose that the 80 persons who did not answer my letter were very likely more careless and indifferent than those who did answer, and that if I had heard from all, a much smaller percentage of readers of our bulletins would have been recorded; and that they were less interested in them in every respect than those who responded. Such a supposition seems hardly warranted after a comparison of the results obtained with those gotten by the Rural Survey, the results of the two studies approaching each other very closely. Indeed, it appears that I am quite fully warranted in concluding that the 70 persons answering were fairly typical of the 80 who did not respond.

The Report by Items were as Follows:—

No. of Bulletin	Received	Read throughout	Read partly or by summary	Preserved and in library
191	47	39	4	25
197	20	8	3	7
198	22	14	2	12
202	16	10	1	8
216	45	35	3	22
226	35	23	4	15
232	45	35	16	29
233	28	16	10	14
234	18	4	2	4
248	36	21	4	18
250	45	25	6	30
253	36	22	4	18
Circular				
95	34	28	1	17
112	44	28	4	23
115	35	24	3	16
137	31	20	3	17

The following gives the titles of bulletins or circulars and remarks, by the present writer:

191. Spraying Apples. Practical bulletin, introducing western methods of spraying. Summary in back end.

197. Catalpa Midge. Bulletin of somewhat technical contents, forms of damage first discussed, then description, then life history and habits. No general summary, but remedies give the important conclusions.

198. Spring Manual of Practice in Economic Zoölogy. Intended as a reference work but apparently not being used as planned. The whole work is a summary constructed on a distinctive plan of its own, and could not be modified to any other plan without losing its individuality.

202. The Raspberry Byturus. First calls attention to damage, then to distribution, description, life history and remedies. No summary, but the important conclusion is stated in paragraph giving remedies.

216. Spraying Machinery. A rural engineering bulletin that has been exceedingly useful as an aid to practical entomology. Every paragraph is a summary and as very little had been published on this subject, we were compelled to let the plan of the bulletin be the outgrowth of work with the specimens handled.

226. The Wheat Jointworm. Discussion of damage first, then life history and descriptive matter intermixed, recommendations at end, no general summary.

232. Spray Calendar.

233. Fall Manual of Practice in Economic Zoölogy. Intended as a reference work and seems to be used in the proper way.

234. Flour Mill Fumigation. A smaller edition than usual, and not sent to all the mailing list. A brief summary at conclusion.

248. Spraying Machinery Accessories. Another rural engineering bulletin, each paragraph of which is itself a summary and summarizing cannot go further. Probably the plan is as good or better than any other would be.

250. Some Ohio Birds. Written especially from the economic standpoint. Summarizing here and there throughout, but no general summary possible.

253. Insect pests of the Household. Each article is a summary of the most

important facts known about each insect. The general plan is quite similar to that used for most bulletins on this subject.

Circular 95. A circular setting forth some rather striking spraying results in an Ohio apple orchard.

Circular 112. Commercial Apple Orcharding in Ohio. Summary of commercial results obtained in a number of Ohio apple orchards through a period of several consecutive years.

Circular 115. The Chinch Bug. An emergency publication issued during a summer of uncommon outbreak.

Circular 137. Grasshoppers. Descriptive of hopper-dozer and discusses results with same and criddle mixture in case of a local outbreak.

Twenty-nine thought the bulletins sufficiently illustrated with photographs and drawings against six who disagreed. Some of the remarks made in this connection were as follows:—"Not all of them"; "Amply so"; "Very satisfactory"; "I believe so"; "Some are, others not"; "I think most of them are." Four said, "I think so"; Others, "Hardly; illustrations are always most acceptable"; "I think so, but better too many than too few"; "For the average person, you could well further illustrate"; and a number of others made remarks of similar tenor.

Six emphasized the importance of the summary, four of them expressing a preference to have it in the front of the bulletin, while one believed it best to put it in the back, because otherwise it encouraged omitting to read the body-contents.

Various suggestions were made on the backs of the letters, most of which, we supposed we had observed in the preparation of the bulletins, and probably could not observe much better if we tried the second time; e.g., one thought each bulletin should carry an index and table of contents in the front, and referred to bulletin 233, the Fall Manual, as an example of defectiveness in this respect. If he received a perfect copy of this bulletin, it has a very copious index which he may have overlooked because of its being in the back. One farmer who said the entomological bulletins were not generally read in his locality, explained why with this sentence: "Wheat, hogs and corn seem to be all the farmers of this locality think about." One said, "Don't send to farmers, bulletins intended chiefly for entomologists and scientists." Most of the answers indicated that the writers were reasonably well satisfied with the bulletins as prepared by us, and a considerable fraction of them were distinctly commendatory. A number were worded very similar to this; "I could offer no suggestions for bettering your bulletins, as they have all proven very interesting and instructive to me by both cuts and substance."

The third method by which I hoped to obtain some information as to the comparative popularity of our different bulletins was to ascertain the number of copies of each that had been distributed during the past six years. However, owing to certain changes, I am obliged to rely upon my own knowledge and recollection in regard to the size of the different editions, and I cannot, therefore, be very definite. At no time during the past six years has our regular mailing list been less than 50,000, and it is at present approximately 60,000, so our regular edition for the run of a bulletin is 65,000. This was the number run of bulletins 248, 251, 253 and circular 137, while 70,000 copies of 250, Some Ohio Birds, were printed.

There are not more than 1,400 copies of No. 250 on hand, about 2,500 of No. 248 (Spraying Machinery Accessories) and something like 800 of No. 251 (Wheat Leaf Miner), while the last copy of No. 253 (Household Insects) is gone; no full edition of any bulletin has ever been more rapidly exhausted at the Ohio station. Of circular No. 137 (Grasshoppers) 1,500 are left. That, in so many cases, the excess of 5,000 bulletins over the regular mailing list is so quickly absorbed, signifies to us, possibly wrongly, that somebody must want to read them, and so many people would not want

to read them, unless many of those on the regular list were reading them and talking more or less about them. We have been obliged to reprint bulletin No. 191 (Spraying Apples) at least three times, in editions of 2,000 to 5,000 copies each, and several hundred copies are still wanted each year. Bulletin No. 194 (Shade Tree Insects) has been reprinted once, and I think twice. So far as I can recall, Bulletin No. 197 (Catalpa Midge) has not been reprinted. The Spring Manual of Practice, No. 198, has been reprinted three or four times. I think No. 202 (Raspberry Byturus) has not been reprinted. Bulletin No. 216 (Spraying Machinery) has been reprinted at least twice and, perhaps more. The Wheat Jointworm, No. 226, I believe has not been reprinted. The Fall Manual, No. 233, has been reprinted at least once, and possibly twice. Several of our circulars have been reprinted several times. I am assured by our mailing clerks that the entomological publications are called for about as frequently as those from any other of our station departments. The Seasonal Manuals are said by them to be in constant demand in the horticultural districts and by the public schools of the state. By every clue that I have been able to follow, I am led to believe that, in Ohio, the entomological bulletins are quite generally read and esteemed, and that about half of the copies mailed are not destroyed, but, after being read, are filed and kept for reference. I distinctly recall that in practically every case when we have issued an important bulletin, we have received soon thereafter, at least a few letters of appreciation and commendation from the rank and file of our readers, thus showing that they have more than a passing interest in them.

If anyone seeks an explanation of the general acceptability of our publications in any formulated plan of arrangment of the subject matter, he will not find it; for every publication has a plan of its own which differs from every other. If there has existed among entomological writers any written or unwritten canons regarding the arrangement of their matter for print, we are obliged to plead having been so ignorant of them that we must have unconsciously violated them in everything, or nearly everything, we have ever written; and I think many, perhaps most, of present-day entomologists share our ignorance. "We" and "our" in this report refer to the Ohio entomological staff, for whom I am presuming to speak in reference to this subject.

The position taken at our last meeting by Mr. Webster, of this committee, was correct, and, if I mistake not, has been occupied, in effect, by a considerable number of our members for a long time. In my judgment, the arguments that sustain his position will show equally well the futility of any attempt to make a very definite formulation of rules or recommendations as to the best form for bulletins. If the writer possesses the gift of "editorial gumption," his bulletins will likely be read and used, while if he has not acquired it, I am very dubious if the most carefully framed rules for construction will help him much.

To the master-writer, rules, forms, models, examples, precedents, are merely general principles wrought into more or less concrete forms, and his work is guided by the flexible principle, never hampered by the cast-iron rule; while, to the less experienced writer, the model is apt to be regarded as a pattern to be imitated. That each entomologist may be enabled to adapt his writings to the limitations of his constituents, always more or less local, he must be practically unlimited.

In several of the departments at the Ohio Station, lengthy bulletins, containing much technical and tabulated matter, are condensed into short circulars, these going to the complete mailing list, while smaller editions of the complete bulletins are issued and sent to specialists and to such constituents as specially request them. We have adopted this plan in the entomological department.

H. A. Gossard.

Report from Iowa

One hundred and ninety-eight circular letters were sent out December 4, 1913, to names selected at random from the Station mailing list; 100 from the horticultural list, 98 from the general list. An attempt was made to select older names from the list, but some people had not received any entomological bulletins. Although a stamped envelope was enclosed, only 46 replies have been received to date, December 27, 1913.

While it is not wise to place great dependence on so few replies, these are given in substance for what they may be worth.

The questions asked followed closely those used by Prof. H. A. Gossard in Ohio, and were of three kinds: (1) those regarding the bulletins sent out, (2) suggestions for improvement, and (3) regarding essential features and arrangement. A résumé of the replies follows.

(1) The data are best presented in tabular form.

Number of replies	46
Bulletins retained by	31
Bulletins not retained	6
Bulletins not received	9

Of the 31 answers where bulletins were retained, 16 replied definitely as to the amount of attention given individual bulletins. In these, data are given on 40 bulletins received. Eighteen of these were read throughout, 33 read in part, by summary, etc., seven were not read.

In general it appeared that approximately five sixths of the bulletins sent out were retained. Of these about four fifths were read by summary, etc., although some people went further than this, and about one half of the bulletins were read throughout.

(2) Here the question was: What would most help to make our bulletins more readable?

There were many suggestions; a few thought the present form was quite sufficient. The features most often suggested were brevity and simple language. Others wanted timely bulletins, reaching them when the insect was causing damage. Other suggestions were: sure remedies, small bulletins, uniform size and plenty of illustrations. One man thought bulletins ought to be sensational.

(3) Here the hypothetical question put was: Suppose that an insect is bothering the roots of your clover, what are the things you want to know about that insect? Where in a bulletin do you think that information ought to be put?

As expected, the remedy was most desired, according to 18 replies. Only nine asked for a life history. As one expressed it, he wanted to know "where the insect came from, how long it stayed, and where it went to, as well as how to get rid of it."

Some replies, evidently written with more care, indicated that the writer recognized the necessity for making sure of the insect concerned, for six wanted a description of it. One asked for a "careful description of the insect at the stage in which it is harmful, a brief life history, and the remedy."

Only one person wished to know the effect on the plant; one, the favorable and unfavorable conditions affecting the insect.

Now regarding the proper place for the sought-for information. The front part of the bulletin seemed to be the favorite position, but almost as many said it made little difference. One thought the essential information should be placed in the concluding portion at the end. The demand for a summary was general, but with no decided preference for its position, except for a conspicuous one.

Concluding, it appears that a fair proportion of entomological bulletins are read and preserved. There is a demand for brevity and simple language. The essentials are, from the standpoint of the practical man, the remedy, a brief life history, and a recognizable description of the insect.

R. L. Webster.

Report from Minnesota

We have in Minnesota 157,000 farms. Our general mailing list of regular Station bulletins, exclusive of extension bulletins, is distributed among the various Divisions about as follows:

Bulletins upon horticulture and forestry	4,750	addresses
" " veterinary science	4,500	"
" " animal husbandry	5,500	"
" " agronomy and farm management	5,750	"
" " agricultural engineering	3,750	"
" " entomology	3,750	"
" " botany and plant pathology	4,000	"
" " chemistry and soils	4,200	"

Many of the above figures represent duplications and the Station bulletin mailing list, exclusive of the Extension Division, is probably in the vicinity of 15,000 names, and practically one-fourth of this number have called for bulletins upon Entomology. Since this number was specifically asked for, it is fair to assume that the entomological bulletins are appreciated, though not necessarily thoroughly read.

Turning to another class of literature, more elementary in language, brief, to the point, and severely practical, namely, the Farmers' Library Bulletins, issued by our Agricultural Extension Department, we find there is a mailing list of approximately 40,000 addresses in Minnesota (about 45,000 all told) representing approximately 26 per cent of the farmers in Minnesota. This list naturally includes the regular Station list. Judging from the inquiries amongst recipients, from observations at the State Fair and from the demand, as well as from the nature of the publications, as above indicated, it is safe to conclude that these bulletins are more generally read and understood than those on the regular mailing list, which fact might be regarded as a suggestion for simplicity and directness in the preparation of all of our bulletins intended primarily as aids to the agricultural classes.

The following we obtained from our Bureau of Farm Economics:—Out of 167 farms visited in a cut-over timber country by our men, recently, 26% received our Extension or Station bulletins and, in a farming county of the Red River Valley, out of 203 farms visited, 34% received Station or Extension bulletins,—the latter being in an agricultural district—showing a little rise, as one would expect, over the cut-over district.

In November, 1911, we published a Farmers' Library Bulletin, about 40,000 copies of #23, dealing in a simple and elementary way with some of our most injurious insects and their control. This issue was exhausted long ago, and there is evidently a demand for information in this line, since we have been asked by the Director of the Extension Division to prepare copy for a reprint.

Turning to another class of our constituents, namely, the State Horticultural Society, with its 3,000 odd members, it is safe to say that they make much more intelligent use of our bulletins than the general farmer; and the results secured by Mr. Gossard in Ohio and reported by him would probably be duplicated in Minnesota.

However, under favorable circumstances, it is very evident that, so far as our constituents in the various states are concerned, out of a mailing list of 40,000, not one in 10,000 read everything. Even the better educated of the recipients, while they may glance over our publications casually, seek only what they need, what fits their

individual case, and the remaining information is generally wasted. The evidence we have at hand, points clearly I believe, to definite features which should characterize the construction and use of entomological bulletins. I think I was practically in accord with views expressed by Mr. Webster of this Committee, last year, when I stated in an address given in Washington in December, 1911, that I believed, as a general thing, that "bulletins treating of some destructive insect should contain first a brief popular description of the insect and its work (placing the account of its work first, for the farmers' benefit) using drawings and photos generously; and, secondly, following the above, remedial and preventive methods. All this should be in *bold-faced* type and should be in a form attractive to the eye. Following this, which represents essential points, of course, from the farmers' standpoint, may well come an account of the work in detail in ordinary type, using whatever illustrations are necessary and available,—the more the better, if they are pertinent."

It is evident to me and I believe to most of us that a large per cent of entomological bulletins sent out on the regular Station mailing lists are wasted and represent the misuse of money. To be sure, they convey to the recipients over the state the idea that the Entomological Department is doing something although the hard-headed farmer, in finding the bulletin uninteresting or unattractive, might form a wrong opinion as to the nature of the activity.

Is it not a fact that the best use to which the entomological bulletins are put is in answering questions,—that is, in lieu of writing letters, questions asking specifically for help in connection with some insect; and if this be a fact, does not the situation call for brevity and simplicity of expression and indicate a demand for popular circulars and leaflets rather than lengthy bulletins upon the part of those who would best serve the agricultural classes?

F. L. Washburn.

On motion the report was accepted and ordered to be filed with the Secretary.

Mr. S. J. Hunter: I think that some action should be taken on the suggestion made by the Executive Committee concerning the publication of annual notes on insects and I would like to move that it is the sense of the meeting that these notes should be published in the manner indicated in the report.

This motion was seconded and carried.

President P. J. Parrott: We will now take up the report of the special committee which was appointed to consider the publication of economic literature and which will be given by Mr. W. E. Britton.

REPORT OF COMMITTEE ON CONTINUING THE BIBLIOGRAPHY OF AMERICAN ECONOMIC ENTOMOLOGY

The Bibliography of American Economic Entomology, formerly published by the United States Department of Agriculture, has proved not only extremely useful, but almost indispensable to all workers in applied entomology. All regret that it was discontinued. Although the matter was recently considered by the federal authorities, no favorable action has been taken.

As it has been suggested that this Association continue the Bibliography, President Parrott appointed this committee to gather data relating to the subject, for

consideration at this meeting. As it has been a short period of time (only a few weeks) in which to investigate, this report must necessarily be incomplete; yet it is hoped that it may be sufficiently comprehensive to enable you to act intelligently in this important matter.

Statistics of the Bibliography

The Bibliography of American Economic Entomology was published in eight parts, altogether containing 1,318 pages, 12,655 citations, and is complete up to January 1, 1905. Since then no indexing has been done.

The Bibliography was printed in 10-point type, the type bed of the page measuring $4\frac{3}{8}$ x $7\frac{1}{2}$ inches in size. Part VIII contained 111 pages, 1,882 citations (or an average of 16.4 per page) and there are 41 lines per page. It has an index of 20 pages set in 6-point type.

Plan for Continuing the Bibliography

In view of the fact that the Bibliography of American Economic Entomology is extremely useful to every applied entomologist; that its special field has not been covered by any subsequent work, and as a consequence almost every economic entomologist is forced to maintain a more or less complete special catalogue (which can be covered more satisfactorily in a general bibliography) and as a result there is throughout the country much undesirable duplication of easily avoided clerical work;—this affects not only entomologists throughout the country, but also the workers in the Bureau of Entomology, and owing to the larger force employed there, this compilation will be more useful in the Federal Bureau of Entomology than to any other similar group of entomologists;—the members of this committee are most strongly of the opinion that the work should be published by the general government, or, if that be impossible, the citations should at least be assembled and indexed in the Bureau of Entomology.

The committee recommends that if other means fail, the American Association of Economic Entomologists continue this Bibliography; that a carefully selected indexing committee or board be appointed to serve without compensation, to consist of five members, who shall be charged with the preparation of the manuscript.

This committee also recommends that the first issue (Part IX) cover the ten-year period from January 1, 1905, to January 1, 1915; that it be printed in a form similar to earlier numbers and under the direction of the editorial board of the Journal of Economic Entomology. Such a publication, including text and index, will probably contain not more than 350 pages, and should be sold at such a price that the early sales will about cover the cost of publishing.

Probable Cost of Publishing Part IX

The cost of printing Part IX depends primarily upon the number of citations. Part VIII contains 1,882 citations, or an average of 374 per year, for the five-year period ending January 1, 1905. There has probably been a substantial increase since then, which cannot be accurately estimated, but allowing for 600 per year or a total of 6,000 citations for the ten-year period, the text would contain not more than 300 pages, if set in 10-point type, with two lines for each reference. The index would not make over 40 pages in 6-point type. If there are more than 6,000 references, the book would be larger. If there are only 5,000 references the text will make about 250 pages.

The approximate cost of publishing has been variously estimated at from $475 to $550 depending upon the type used. These figures include paper and press work and are based on an edition of 1,000 copies.

Plan for Financing the Bibliography

As the Association has at present no fund adequate to defray the cost of such a publication, the committee recommends that Part IX be sold to all who desire it, at such a price that the amount obtained from the early sales will nearly cover the cost of the whole edition, leaving the proceeds of later sales to aid in publishing future issues of the Bibliography or similar works. According to the list of 1912, this Association has an American membership (both active and associate) of 328, and 54 foreign members. A good proportion of American members, as well as a few foreign members, will doubtless purchase the Bibliography either for private use or for their department libraries and some will take a copy for each. Many institutions and large libraries will surely purchase one or more copies later.

This committee, therefore, recommends that after the manuscript has been prepared, the Secretary of this Association, through correspondence and by means of advertisements in the Journal or elsewhere, obtain advance orders for Part IX of the Bibliography at a price, depending on the cost of publication and upon the number of advance subscriptions, to be fixed later by the editorial board of the Journal, which should also be given authority to decide on all details of publishing the Bibliography not otherwise covered by this report.

The members of this committee have known for some time of the manuscript Catalogue of the Described Transformation of American Lepidoptera prepared by Mr. A. N. Caudell. We learn that there is no prospect of its being published by the government, and it has been suggested that this also may be undertaken by the Association. The work would comprise about 600 pages and can be printed in an edition of 500 copies for about $1,200. If this organization would become responsible for the project, this great aid to economic workers could be sold for about $6 per copy with a very fair prospect that the organization would recoup expenses, or nearly so, with the sale of 200 copies within a year of issue. In view of the great value of the work to our members and the prestige incident to its publication, we believe this a highly desirable line of activity for the Association. We, therefore, recommend that the editorial board be authorized to arrange for its publication if found desirable.

All of which is respectfully submitted:

W. E. Britton, *Chairman.*
E. P. Felt,
J. J. Davis,
Committee.

Mr. W. E. Britton. I would recommend that if there is time to discuss this matter it might be well to do so now, but that final action on the report be delayed in order that the members may have an opportunity to consider it thoroughly.

Mr. J. M. Aldrich: Mr. J. J. Davis, a member of this committee, was not able to attend this meeting but asked me to say that he was very much in favor of the publication of the bibliography of economic entomology by the Association and I am sure that he would endorse that part of the report if he were present.

Mr. W. C. O'Kane: I would like to inquire the reasons for deferring the publication of the bibliography until the completion of the ten-year period, rather than going ahead with it for a five-year period.

I believe that there is urgent need of having the bibliography published and I would personally be in favor of having the matter covered by the first five-year period published as soon as possible.

MR. W. E. BRITTON: The only reason is that it is rather more convenient to have the bibliography bound in volumes covering five or ten years, and as it will take a year or more to prepare the matter for publication, we thought that a single volume would cover the ten-year period.

By general consent action on this report was deferred until a later session.

PRESIDENT P. J. PARROTT: An amendment to the constitution has been proposed and is printed in the program. It is necessary that a committee be appointed to consider this matter and report later in the meeting. I will, therefore, appoint the following members to serve on this committee: Mr. W. E. Britton, Mr. Franklin Sherman, Jr., Mr. S. J. Hunter.

PRESIDENT P. J. PARROTT: Is there any further business to be taken up at this time?

SECRETARY A. F. BURGESS: I have a letter from Doctor Howard in regard to the report of the committee on policy of the American Association for the Advancement of Science with reference to the places of holding future meetings, and it seems well to bring this matter up at this time so that the proposed arrangements can be considered at this meeting.

EXTRACTS FROM MINUTES OF COMMITTEE ON POLICY
November 17, 1913.

"A discussion as to the future meetings of the Association was taken up and, on motion, it was resolved to recommend to the next General Committee that Toronto be selected for the convocation week meeting of 1915–1916.

"It was resolved that efforts be made to hold large representative convocation week meetings at four-year intervals, the first to be held in New York in 1916–1917 and the second in Chicago in 1920–1921.

"The Permanent Secretary was ordered to report to the affiliated societies that the Committe on Policy has under consideration the advisability of meeting in 1917–1918 at Columbus, Urbana or Cincinnati, in 1918–1919 at Boston, and in 1919–1920 at St. Louis or Nashville.

"On motion, the Permanent Secretary was instructed to inform the affiliated societies that the Committee on Policy has recommended that efforts be made to hold large convocation week meetings in New York in 1916–1917 and in Chicago in 1920–1921, and to inform the affiliated societies that he has been instructed to forward this information that the societies may plan accordingly."

I might say in connection with this matter that a number of members have suggested to me that this plan provides for no meetings

in the City of Washington. It has also been suggested that as it is the policy of the Association of Agricultural Colleges and Experiment Stations to hold a meeting in Washington, D. C., every other year, that this Association might think it advisable to meet occasionally with the Association of Agricultural Colleges and Experiment Stations in Washington in order to give the Washington members and other members who desire to go to Washington to consult libraries and museums, a better opportunity to visit that city.

On motion the Chair was authorized to appoint a committee to consider this matter and report at the last session.

The following committee was appointed: Mr. H. T. Fernald, Mr. T. J. Headlee, Mr. Glenn W. Herrick.

At the session on Friday morning, January 2d, the closing business of the meeting was transacted.

PRESIDENT P. J. PARROTT: I will now call for the report of the Committee on Amendment to the Constitution.

REPORT OF THE COMMITTEE ON THE CONSTITUTION

Considering that the Association now has two vice-presidents, one of which presides over the section of Horticultural Inspection and the other over the section of Apiary Inspection; that in the absence of the President there is no regular officer to preside over the general meeting if held at the same time as the section meetings; and that it is often impossible for all of the officers to be present,

Therefore, the committee recommends the adoption of the proposed amendment to the Constitution as published in the program providing for "one vice-president and an additional vice-president for each section."

While the committee was considering the amendment to the Constitution, it also took up the question of the by-laws, especially regarding the dues, and begs leave to submit the following for future consideration:

The committee suggests that beginning with the year 1915, the annual dues be increased; that the dues of active members be raised to two dollars ($2.00) and those of associate members to one dollar ($1.00). This necessitates an amendment to the by-laws which cannot be acted upon at this meeting, but the committee recommends that the Secretary-Treasurer be instructed to publish a notice of this change in season for action at the next annual meeting.

W. E. BRITTON,
S. J. HUNTER,
FRANKLIN SHERMAN, JR.,
Committee.

MR. E. P. FELT: I move that the recommendations of the committee be adopted.

MR. C. GORDON HEWITT: I should like to second that motion but think it should be made clear that the vice-presidents who preside over the sections should be designated so that there will be no misunderstanding.

President P. J. Parrott: I think that this is implied in the report and unless there is objection the vice-presidents will be designated so that there will be no misunderstanding as to the sections over which they will preside.

Mr. H. T. Fernald: I would like to ask whether one vice-president for the general Association is likely to be always sufficient. I recall at least one meeting at which at the last moment we found that one of the vice-presidents was unable to be present. If we had not known before that the president could not be there and if we had not a second vice-president we would have been without a president *pro tem.* It is merely a question of whether or not more than one vice-president for the general Association might be advisable.

Secretary A. F. Burgess: It seems to me that the number provided for in this amendment will, except in extreme emergency, be sufficient. At the St. Louis meeting a number of years ago, only one officer of the Association was present. That happened to be myself, who was Secretary at that time. But the late Dr. James Fletcher was called to the chair to preside and we had a most enjoyable meeting, and I think if such emergency should arise again we would probably get along as nicely.

Mr. E. P. Felt: It seems to me that if the president and vice-president-at-large were both absent, the first sectional vice-president could call the meeting to order and complete the organization.

On motion the report of the committee was accepted and its recommendations adopted.

President P. J. Parrott: I will now call for the report of the committee on Publication of Economic Literature.

The report which was presented at the first session was read by Doctor Britton and at the suggestion of Doctor Felt the part of the report concerning the publication of the bibliography of economic entomology was considered first.

Mr. W. M. Wheeler: I would like to inquire if it is to be the general policy of the Association to go into the publication of entomological literature.

President P. J. Parrott: I do not think so. The question to be considered is in regard to the publication of the bibliography.

Mr. W. M. Wheeler: As I understand it, the recommendations of the committee are made in case the government will not undertake the publication of the bibliography. It occurs to me that there are other alternatives. It is the function of many academies and scientific institutions to publish papers that cannot be handled by Journals, and it seems to me that it might be worth while to see whether this paper could not be published by some of these institutions. I am

personally very pessimistic about the publication of such papers in the hope of getting back the cost of the publication. Our smaller Journals find it difficult to escape a deficit at the end of the year. I think we ought to be very careful about attempting the publication of large works which might involve the finances of the Association.

Mr. W. E. Britton: It seems very difficult to get any one to publish this bibliography. The Department of Agriculture at Washington takes the stand that the *Experiment Station Record* already covers the field and that it is not desirable to duplicate the work. I do not know that this is a part of the general policy for this Association to begin publications. It is believed that we could have the manuscript prepared and secure enough advance subscriptions to the publication so that we would be warranted in having it printed.

Mr. C. Gordon Hewitt: Would it not be better for the Association to first undertake the preparation of the manuscript without making advance arrangements in regard to publication. It would then be possible to negotiate with some of the institutions as suggested by Doctor Wheeler, with a view to seeing whether they would be willing to publish it. In case they would not, we could take up the matter of publishing it, but before the Association commits itself to publication I think that we should be certain that we will not be in a position to lose, that is, we should be sure of having enough advance subscriptions to cover the cost of publishing. We have now become incorporated and the whole Association would be more or less responsible for the obligations incurred.

Mr. W. E. Britton: I think the views of Doctor Hewitt are very similar to those entertained by the committee, except that we would not wish to prepare the manuscript unless there was a general sentiment in the Association favoring its ultimate publication. We would like to have the work all done by the Bureau of Entomology, if this is possible, but in case it cannot be done in that way it will be necessary to take it up by a number of men coöperatively, and this, of course, will involve a tremendous amount of work.

Mr. C. Gordon Hewitt: Has the Department of Agriculture definitely refused to undertake this work?

Mr. W. E. Britton: I do not know that they have definitely refused, but they do not talk very encouraging concerning it. We hope that the Department will act favorably.

Mr. C. Gordon Hewitt: Would it not be best to definitely approach the Department first and find out whether it will or will not publish the bibliography? If a negative reply is given, then I think the Association could take up the question of its preparation. After it is prepared the matter of publication could be taken up with other

institutions. I think this would be the safest policy, and it seems to me the most desirable.

President P. J. Parrott: Something has already been done with reference to approaching the authorities for the purpose of securing this publication. In case of complete failure this provides for the Association to do the publishing.

Mr. E. P. Felt: From my viewpoint I regard the bibliography of economic entomology as exceedingly useful and as a business proposition I believe that practically every important entomological office in the country could afford to pay $10 a year rather than to be subjected to the annoyance of getting along without it. As has already been stated, repeated efforts have been made to interest the federal authorities in its publication and if the matter goes over for another year on the present basis, it will mean that in January, 1915, we will be in about the same position as we are now, unless we can secure favorable action. On the other hand, if the matter is put into the hands of a committee which is given authority to first exhaust every available source of publication, and in the event of that failing to arrange to have the references assembled during the year, we would have the data in shape in 1915. Of course the expense is something, but I would rather lose $5 on a venture of this kind and be moderately sure of having the bibliography for reference in 1915 or 1916, than to let the matter drift. This publication will be a help to every entomologist and if this Association is for the advancement of economic entomology, it seems to me that in this form of activity we have something which ought to be exceedingly useful.

Mr. W. C. O'Kane: I would suggest that before the bibliography can possibly be published, this Association will meet again. The work of preparing the references should begin soon, but I do not believe that the committee should attempt this work unless there is some assurance that the manuscript will be published. It seems to me that the maximum price mentioned in the report may be too low and I think the price should not be decided on until further information is secured as to the size of the publication.

Mr. C. Gordon Hewitt: I do not wish to be misunderstood in regard to the suggestions I have made, for I agree with the previous speakers that it would be unfair to the committee for them to prepare the data unless there was certainty that it would be published. Everyone agrees as to the enormous value of the work, but I think the question of publication could be decided at the next meeting after the manuscript was more or less prepared. I am perfectly willing to stand my share of any losses and to subscribe for a number of copies.

Mr. W. M. Wheeler: In the publication of such works which are

very necessary to entomologists I find that institutions will take a single copy and that in many cases none of the people connected with the institution will subscribe. The number of publications has increased enormously within recent years and there is much free literature and many reprints of articles distributed so there is less sale for complete publications to individuals. Some of the men who feel that they would like to have a copy may not be able to subscribe, although we all agree that this is of utmost value and should be published.

Mr. W. E. Britton: Many of the members of this Association already own the earlier numbers of this bibliography. These were printed by the Department of Agriculture and distributed free. They are catalogued by second-hand book dealers and have a definite value. Those of us who have the earlier numbers would undoubtedly buy the one which it is proposed to publish, so as to have a complete set. For this reason there would probably be a larger sale than otherwise.

Mr. E. P. Felt: The committee in preparing this report made a canvass of the probable sale of this publication basing it somewhat on the subscription list to the Journal and assuming as a basis that only one quarter of the Journal subscribers would purchase the bibliography, we would have sale for about 175 copies. Taking another basis for estimate, there are 50 states which have one or more entomological institutions and in each one of these states, it is fair to assume, one entomological office and one entomologist (or two entomological offices and no entomologist), would each subscribe, this would give a sale for approximately 100 copies. It is probable that subscriptions could be obtained from approximately 100 libraries, so that the probability of securing orders for 200 copies is very good and this could be made to cover most of the expense involved.

Mr. T. J. Headlee: I move the adoption of the first part of the report. (Seconded.)

Mr. W. C. O'Kane: I would like to offer an amendment, so that the maximum price of the publication may be determined by the Association at a later date.

It was voted that the motion as amended be adopted.

President P. J. Parrott: We will now consider the second section of the report which relates to the publication of the manuscript prepared by Mr. Caudell.

Mr. Herbert Osborn: I move that the consideration of this part of the report be postponed until next year. (Seconded.)

Mr. W. E. Britton: I would like to say that the manuscript is already for the printer. It has been submitted to the Department of Agriculture, the Carnegie Institution, and many other organizations, but they are all unable to publish it. The matter contained in it is

Edwards' Catalogue of Lepidoptera brought down to date. Doctor Howard states that the Bureau of Entomology would furnish the manuscript in perfect condition for printing and Mr. Caudell would be willing to read the proofs.

MR. HERBERT OSBORN: I would like to say that while I appreciate the importance of this publication, that we are now committed to the other project and have undertaken a rather large financial obligation. The bibliography, I think, is essential to every entomologist. This publication would have a more restricted use than the bibliography. It would, of course, be of great value, but it seems to me we ought to go rather slowly. I do not want to throw cold water on the project but simply feel that we should be a little cautious.

MR. E. P. FELT: I hardly agree with the previous speaker that this publication is likely to have a small circulation. I think it would appeal very strongly to all economic entomologists, and it would be valuable to a great number of systematists, collectors and a large number of people who would hardly be classed as entomologists.

By vote of the Association further consideration of this matter was postponed until the next annual meeting.

PRESIDENT P. J. PARROTT: I will now appoint the following committee to take charge of the publication of the bibliography of economic entomology: Mr. E. P. Felt, Chairman, Mr. W. E. Britton, Mr. W. E. Hinds, Mr. W. C. O'Kane, Mr. A. F. Burgess.

PRESIDENT P. J. PARROTT: I will now call for the report of the Committee on Auditing.

REPORT OF THE AUDITING COMMITTEE

Your committee has audited the books and accounts of the Secretary of the Association of Economic Entomologists and the Business Manager of the JOURNAL OF ECONOMIC ENTOMOLOGY and finds them correct.

J. G. SANDERS,
E. C. COTTON,
Committee.

Voted that the report of the committee be accepted.

PRESIDENT P. J. PARROTT: The next business will be the report of the Committee on Resolutions.

REPORT OF THE COMMITTEE ON RESOLUTIONS

Your committee on resolutions begs leave to report as follows:

Resolved, That we express our appreciation of the courtesies of the people of Atlanta, Governor Slaten and wife, the State Entomologist and staff, Atlanta Convention Bureau, Capital City Club, University Club, Local Press and the Atlanta Medical College; of the officers of the Association for their effective work and especially the President for his admirable address, the Secretary for his earnest and efficient work in behalf of the Association, and the Editor of the JOURNAL for the successful continuation of this enterprise;

That we heartily commend the efforts being made by the New England States and Canada toward the control of the gipsy and brown-tail moths, which stand as such a serious menace to the whole country, and express the hope that this vigilance be in no degree relaxed, that coöperation with Federal control be maintained and that the officers charged with the enforcement of the Quarantine Regulations against these pests be supported in every possible manner to the end that the spread of these pests throughout the country be retarded to the greatest possible extent.

That the individual members of this Association, wherever located, be urged to use every opportunity to further general support of the Quarantine and Inspection Regulations in order that the greatest measure of success may follow their enforcement.

Respectfully submitted,

HERBERT OSBORN,
GEO. A. DEAN,
WILMON NEWELL,
Committee.

Voted that the report be adopted.

PRESIDENT P. J. PARROTT: We will now listen to the report of the Committee on Membership.

REPORT OF THE COMMITTEE ON MEMBERSHIP

The Committee on Membership recommends:

(1) That in case active members desire to nominate associate members for active membership they shall file such nominations with the chairman of the membership committee at least three months prior to the annual meeting; such nominations shall be accompanied by full information concerning the nominee's publications and other qualifications.

(2) That nominations for foreign membership together with full information concerning the publications and other qualifications of the nominee shall be filed with the chairman of the Committee on Membership at least three months before the annual meeting.

The committee recommends:

For transfer from associate to active membership:

Hyslop, J. A., Hagerstown, Md.
Peairs, L. M., Morganstown, W. Va.
Schoene, W. J., Blacksburg, Va.
Shafer, G. D., East Lansing, Mich.

For associate membership:

Aldrich, J. M., Lafayette, Ind.
Anderson, G. M., Clemson College, S. C.
Barrett, E. L., Grantsville, Utah.
Bilsing, Sherman W., College Station, Texas.
Classon, P. W., Lawrence, Kansas.
Crawford, D. L., Tampico, Mexico.
Davis, Irving W., New Haven, Ct.
Dove, W. E., Dallas, Texas.
Eagerton, H. C., Marion, S. C.
Gibson, E. H., Greenwood, Miss.
Hawley, Ira M., Ithaca, N. Y.
Hayes, William P., Manhattan, Kansas.
Hood, Clifford E., Melrose Hlds., Mass.
Kewley, Robert J., Lafayette, Ind.
Laake, Ernest W., Dallas, Texas.
Leiby, Rowland W., Ithaca, N. Y.
Loftin, U. C., New Orleans, La.
Lowry, Quincy S., New Haven, Ct.
Marshall, W. W., College Station, Texas.
Matheson, Robert, Ithaca, N. Y.
McDaniel, Miss Eugenia, E. Lansing, Mich.
Millen, F. Eric, E. Lansing, Mich.
Nougaret, R. L., Walnut Creek, Calif.
Parker, Ralph R., Amherst, Mass.

Preston, Harold A., Melrose Hlds., Mass.
Stafford, E. W., Agricultural College, Miss.
Swaine, James M., Ottawa, Canada.
Talbert, Thomas J., Columbia, Mo.
Thomas, W. A., Clemson College, S. C.
Tower, Daniel G., Amherst, Mass.
VanZwalenwenberg, Reyer H., Mayaguez, Porto Rico.
Welch, Paul S., Manhattan, Kansas.
Woodin, G. C., E. Lansing, Mich.
Wooldridge, Reginald, Melrose Hlds., Mass.

The committee recommends the resignations of C. H. Fernald, J. G. O. Tepper, A. O. Pike, and J. F. Zimmer be accepted, and that the Secretary be requested to express to C. H. Fernald and J. G. O. Tepper, the regrets of the Association of Economic Entomologists, that they feel obliged to discontinue their formal connection with the Association.

The committee recommends:

That the Secretary be instructed to notify the three active members and the eight associate members who are in arrears for dues for two years, and the three associate members who were elected last year who have not paid their first year's dues, and if such dues are not paid before the next printed list of members goes to press, to drop their names from the roll.

H. E. Summers,
R. A. Cooley,
Wilmon Newell,
Committee.

Mr. T. J. Headlee: I move that the report be adopted. (Seconded.)

Mr. Herbert Osborn: I would like to offer an amendment that in the case of Prof. C. H. Fernald, whose name was mentioned in the report, that the Secretary be instructed to remit dues and that Professor Fernald be retained on the roll.

The amendment was seconded and the original motion as amended was adopted by unanimous vote.

President P. J. Parrott: I will now call for the report of the Committee on Future Meetings.

REPORT OF THE COMMITTEE ON FUTURE MEETINGS

The Committee on Future Meetings presents herewith the following report:

The committee is of the opinion that the interests of the members of this Association are not only closely related to the American Association for the Advancement of Science, but also to the Association of Agricultural Colleges and Experiment Stations.

The recommendation is therefore made, that this Association continue to meet with the American Association except perhaps once in three or four years, but at those times it meet with the Association of Agricultural Colleges and Experiment Stations at some time when that Association shall meet in Washington, D. C.

The explicit recommendation is offered, based on the last statement, that this Association meet with the American Association one year from this time, and with the Association of Agricultural Colleges and Experiment Stations at Washington in 1915.

Respectfully submitted,

H. T. Fernald,
Thomas J. Headlee,
Glenn W. Herrick,
Committee.

MR. H. E. SUMMERS: It seems to me that there is one portion that is to be somewhat regretted. The American Association for the Advancement of Science will undoubtedly meet in Toronto in 1915–1916, and I do not think we should lose the opportunity of meeting with that Association in Toronto at that time.

MR. E. P. FELT: I think it would be desirable to hold our meeting at Toronto in 1915. There are many important entomological problems on the other side of the border.

MR. WILMON NEWELL: I move the adoption of the report. (Seconded.)

MR. H. E. SUMMERS: I would move that the report be amended so that the question of the place of holding the annual meeting in 1915 be decided at our next annual meeting.

By vote of the Association the report as amended was adopted.

PRESIDENT P. J. PARROTT: I will now call for the nomination of the JOURNAL officers by the Advisory Board.

MR. HERBERT OSBORN: We nominate the present staff of the JOURNAL, as follows: For editor, Dr. E. P. Felt; associate editor, Dr. W. E. Britton; business manager, Mr. A. F. Burgess. We also recommend that the price of the JOURNAL to non-members, beginning January 1, 1915, be raised to $2.50 per year, provided the dues to members of the Association are increased at the next meeting as is contemplated in an amendment to the by-laws of the Association.

The recommendations of the Board were adopted.

PRESIDENT P. J. PARROTT: I will now call for the report of the Committee on Nominations, by Mr. W. D. Hunter.

REPORT OF THE COMMITTEE ON NOMINATIONS

The committee nominates the following:
For president, Dr. H. T. Fernald.
For vice-president, Prof. G. W. Herrick.
For vice-president for Horticultural Inspection, Dr. W. E. Britton.
For vice-president for Apiary Inspection, Prof. Wilmon Newell.
For Committee on Nomenclature: Dr. E. P. Felt.
For Committee on Entomological Investigations: Dr. W. E. Hinds.
For Councillors of A. A. A. S. Prof. H. E. Summers, Prof. Herbert Osborn.
For Committee on Membership, Prof. W. C. O'Kane.
For Entomological Employment Bureau, Dr. W. E. Hinds.
For Advisory Board of JOURNAL, Dr. L. O. Howard, Prof. Wilmon Newell.

Respectfully submitted,

W. D. HUNTER,
F. L. WASHBURN,
R. A. COOLEY,
Committee.

MR. S. J. HUNTER: I move that the report be adopted and that

the Secretary be instructed to cast the ballot of the Association for these nominations.

This motion was seconded and carried.

The ballot was cast by the Secretary and the President declared those members named by the committee to be the officers of the Association for the ensuing year.

President P. J. Parrott: Is there any miscellaneous business to be transacted?

Mr. T. J. Headlee: I would like to inquire if some method cannot be devised so that the meeting of the sections on apiary inspection and horticultural inspection will not be held co-incidentally with the meetings of the general Association. Yesterday, with the exception of the first meeting in the morning, I was unable to hear the program presented before the general meeting of this Association. I would like to attend all of the sessions and there are other members who have had the same experience. In talking with the Secretary of the Entomological Society of America and with the Secretary of this Association, it appears that if the titles of papers were received promptly, it would be possible to arrange the program more satisfactorily. If it is only a matter of securing the titles before a certain date it would be a very simple matter to solve this problem. I therefore move that it is the sense of this meeting that the Secretary be instructed to fix a definite date before which the titles of all papers to be presented at the next meeting should be in his hands, and that titles received after that date shall not be admitted to the program. (Seconded.)

Mr. E. P. Felt: I sympathize with Doctor Headlee's motion and its intention. The only difficulty is that this rule might prevent us from hearing some extremely important papers. Would not an appeal to the common-sense of the members be sufficient to accomplish the desired results.

Mr. T. J. Headlee: It did not do so this year.

Secretary A. F. Burgess: Perhaps I can clear up matters a little by explaining the situation. In order to have the Journal printed on time and to include the program so that it can be in the hands of members and not become lost in the rush of mail at Christmas time, it is necessary to receive the titles of papers about the middle of November. Our contract with the printers provides that they can require 30 days to get out the copy after it reaches their hands. In the last issue of the Journal an index is prepared which is of advantage to everyone, but this index cannot be made up until the last issue is in page proof. This makes a delay in printing and mailing. This year the preliminary notices of the meeting were sent out and the

date of expiration before which titles should be received was fixed as November 12. At that date it was apparent that the number of papers that would be on the program at this meeting would not be very large. The number of titles received for the meetings of the section on horticultural inspection was very small indeed and only one paper was received for the section on apiary inspection. That was the condition when the program was made up and the time was allotted, believing that the sectional meetings would be very light and that there would not be serious interference with the general meeting of the Association. On the general program of the Association the papers were classified so as to interfere as little as possible with the sectional programs. Between the time that the program went to press and the galley proof was returned, a considerable number of titles were received and these were inserted in the proof. After the program had been printed and distributed more titles were received, so that this explains the practical difficulty with which the Secretary is confronted if he tries to accommodate all the members who wish to send in titles. Last night on talking with Doctor MacGillivray, secretary of the Entomological Society of America, it was suggested that the meetings of this Association be held during the first part of the week, and that those of the Entomological Society of America take place later in the week. This arrangement will undoubtedly give us an opportunity to hold the sectional meetings with less interference than we have had at this meeting. If we meet at Philadelphia next year there will be a heavy program and it will take considerable planning to arrange it satisfactorily. I can assure you that the Secretary will be glad of any suggestions which will aid in making the program more satisfactory.

Mr. Herbert Osborn: I would like to ask the Secretary if it would not be possible to print the program separately from the Journal. This might avoid the difficulty of reading the proof of the Journal and the expense of sending out separate programs would be a minor consideration.

Secretary A. F. Burgess: This would probably result in allowing the titles to be sent in several days later than in previous years, but still it would be necessary to forward the programs in good season owing to the large amount of mail which is handled at Christmas time. I do not think there is serious difficulty in getting out the Journal if the titles come in promptly so that we have the business to handle. We don't get the titles promptly and this makes difficulty in handling them.

Mr. E. P. Felt: It would not save materially in making up the Journal whether we had the program in it or not. Sometimes we are delayed a little on account of the program.

By vote of the Association the motion was carried.

Mr. E. P. Felt: Inasmuch as we are now a corporation, I move that the Executive Committee be authorized to have an official seal prepared.

It was voted that the Executive Committee be so authorized.

Mr. A. W. Morrill: I would like to call the attention of the Association to the plan which is being used by the botanical section, of presenting abstracts instead of complete papers. This plan has been found to work very satisfactorily and if we adopted it and limited abstracts of papers to five minutes we would save considerable time. I would move that at the next meeting this plan be adopted and that abstracts not to exceed five minutes be presented instead of papers. (Seconded.)

Mr. E. P. Felt: There is one question that comes up in this connection and that is the practical question of publication. If the Association is to attempt to publish papers presented before it by abstract we may be undertaking a rather large contract. It is my opinion that some papers, at least, which have been prepared in the past, were practically abstracts and published as papers. If we had some very extended papers we would get into difficulty if we undertook to publish them in full on account of our limited means.

Mr. Franklin Sherman, Jr.: Do we not have a rule that limits papers to 15 minutes? It seems to me that that length of time is short enough.

Mr. Wilmon Newell: I would like to offer an amendment to the motion, that it is the sense of this Association that a party presenting a paper should give an abstract rather than read the paper in full.

The motion, as amended, was adopted by the Association.

Mr. W. E. Britton: Before we adjourn I would like to request the members to forward to me as many current notes as possible for publication in the Journal.

A question: Is a man supposed to apply for transfer from associate membership to active membership?

Mr. H. E. Summers: I think the custom has been that it is not good form for an associate member to apply direct. It is rather a matter of individual taste. In many cases associate members who are worthy of active membership have not been selected for years, because the committee has not had their names under consideration. Under the new plan, which will be carried out by the membership committee, of which Prof. R. A. Cooley is chairman, for the next year, the committee will go over the list of associate members and it is always good form to ask the committee in going over the list to consider the name of any one who should be promoted.

SECRETARY A. F. BURGESS: I find that most papers delivered at the meeting have been handed in. I would like to state, however, that unless there is decided objection I shall depend on the members, who have presented papers, to forward them promptly so that they can be published.

MR. W. C. O'KANE: In connection with the program, would the Association think it worth while next year to have a few minutes reserved on the program for a question box, so that such matters as apparatus and equipment can be considered and discussed.

PRESIDENT P. J. PARROTT: What shall we do with this suggestion?

MR. E. P. FELT: Receive it gratefully without formal action.

Thereupon the Association adjourned.

PART II, PAPERS AND DISCUSSIONS

PRESIDENT P. J. PARROTT: I will ask First Vice-President Worsham to take the Chair.

VICE-PRESIDENT WORSHAM: We will now listen to the annual address of our President.

THE GROWTH AND ORGANIZATION OF APPLIED ENTOMOLOGY IN THE UNITED STATES

By P. J. PARROTT

I am deeply conscious of the honor which I enjoy, and the responsibility that now rests upon me in presenting the annual address to this Association. With this brief acknowledgment it should also be stated that I have shared the perplexity of my predecessors in this chair as to choice of subject; but as this is the twenty-sixth annual meeting of this organization, which therefore constitutes the first gathering of this society for the new quarter-century—an appropriate time for a review of past activities—I have chosen for my theme, "The Growth and Organization of Applied Entomology in the United States."

The selection of this topic was prompted by the consideration that a conspicuous feature of entomology, especially during the past twenty-five years, which covers the life of this society, was the rise of the entomological expert with his official connections and of organizations of workers engaged in the promotion of agriculture—a movement which has exerted a profound influence on the aims and success of this branch of science in this country. A discussion of this subject must necessarily be of a somewhat cursory nature, and general rather than specific,

as there are several subdivisions under this head that might be individually treated at length and deserve detailed consideration.

Ultilitarian Development of Entomology

Subjects, it is said, arise according to the atmosphere of civilization, and take color, value and strength in proportion to their connections with the real life of the people. This is, in brief, the history of all departments of science, and such has been the experience of economic entomology. Once the study of the lover of the open fields—the student of nature—this branch of science has taken on larger value and importance, and has now become a profession, which is calling to its service men of serious intellectual power who are engaged in real constructive work for the welfare and prosperity of mankind. In the acquirement of knowledge in the domain of injurious insects and in the quest for large economic results, entomology in the United States has made rapid and substantial progress. The opportunity here for economic studies has been great, for agriculture has always been the leading occupation of our people and a great source of national wealth; while insects, on the other hand, have constituted one of the chief handicaps to agricultural prosperity, and are of increasing significance.

A study of agricultural literature, even in the days when science did little directly for agriculture, shows that there were few subjects which more widely received attention from our farmers than that dealing with insects. Historically, there has been a direct and important connection between the appreciation of the practical value and the necessity of entomological knowledge on the part of the American farmer and the progress of entomology in this country. Inability of individuals to cope successfully with destructive species led to applications to legislatures for assistance. Under state aid a new form of public activity was brought to the service of agriculture, while under the stimulus of liberal financial assistance from both the federal and state governments there has been a remarkable elaboration of new thoughts, lines of effort, and organizations of workers that have counted constructively for the demonstration of the practical value and importance of entomology. It is pertinent to my subject to note at this time some aspects of the rise and growth of entomology under public support and some developments that have taken place in the organization of efforts in the behalf of agriculture.

History of State Aid in Applied Entomology

Legislative aid to entomology was the inspiration of Massachusetts, which was the first state[1] to extend financial assistance for an entomo-

[1] L. O. Howard, U. S. Dept. of Agr. Yearbook, 1899, p. 136.

logical survey, with the special object in view of giving a careful and intelligent consideration of the injurious insects within its confines. This was one of several lines of efforts undertaken by the commissioners of the Zoölogical and Botanical Survey of this state, which received its official instructions in 1837. The purpose of this movement was to "collect[1] accurate information of the state and condition of its agriculture and every subject connected with it, point out the means of improvement, and make a detailed report thereof, with as much exactness as circumstance will admit." In the division of duties Dr. Thaddeus Harris, as one of the commissioners of the survey, assumed responsibility for the entomological project. Differing from the usual conceptions of the work of a natural history survey, his aim in this effort as expressed by himself was to fill the want of a work, combining "scientific and practical details on the natural history of our noxious insects," which would be at least interesting and useful to the great body of the people. His contribution to the work of the survey was his remarkable treatise on "Insects Injurious to Vegetation." Because of his service in this undertaking, Harris has been referred to as the first official economic entomologist in this country. However, aside from the above achievement, he carried on his entomological activities independent of official connections. A naturalist at heart, he pursued his studies, for which he was remarkably gifted by nature and intellectual training, from a sense of love of the work itself.

As in Massachusetts, legislative support for entomology in New York has its inception in the Natural History Survey, which under the influence of public interest was begun in 1837, and has practically continued to the present time. One of the motives back of this effort was the advancement of agriculture, as this industry and mining were considered the two subjects to be most benefited by the proposed project. For the work to be undertaken in behalf of agriculture Dr. Ebenezer Emmons[2] was recommended by the State Agricultural Society, and he was thereupon appointed by Governor Seward, at the same time retaining his title as State Geologist. It was understood at the outset that his reports should be completed in one year. However, Emmons was not prepared to publish his contributions for several years after the undertaking was begun, and the first of his reports did not appear until 1846. Five volumes were eventually complied by him under the title "Agriculture" in the "Natural History of New York," and of these, one volume dated July 25, 1854, is devoted to insects injurious to agriculture. The author, a geologist by profession, states that a part of his labor was to collect materials in the field, and

[1] A. C. True, U. S. Dept. of Agr. Yearbook, 1899, p. 162.
[2] Letter from Dr. John M. Clarke, N. Y. State Museum, Aug. 19, 1913.

another to "collect them from the researches of others," among whom Dr. Asa Fitch is mentioned. Emmons' contribution to entomology is of much the same nature as other reports of the Natural History Survey dealing with zoölogy, etc., in that it is largely devoted to the enumeration of species, with more or less detailed descriptions, while the economic contributions are small. This may be explained by the fact that the author was working in a field outside of his own speciality.

Following on the heels of the foregoing surveys, there arose a distinct type of entomological service, maintained by a public fund provided by taxation, which in scope and influence marks an advanced step in applied entomology in America. This new movement dates back to the fifties and sixties of the last century and had its origin in agricultural societies in different states, which at this time were the most prominent and influential organizations in encouraging and directing those things which would improve and develop the agricultural interests of the different states. Credit for a new departure with respect to entomology belongs to the New York Agricultural Society, which, it appears, was dissatisfied with the progress, if not with the value of the work of the Natural History Survey in the furtherance of agriculture. A specific complaint was made by this Society that the state had made a thorough examination of all departments of its natural history except its insects, and that the publications as a whole were too purely scientific in their character to be of special value to the great mass of citizens. For the distinct purpose of completing the work of the survey in this particular, the legislature appropriated one thousand dollars with which to commence this undertaking. It is, moreover, of interest to note that this project was placed in charge of the State Agricultural Society that the "investigations might be conducted with a direct reference to economy, as well as scientific accuracy." Dr. Asa Fitch, a physician by training and an enthusiastic student of insect life, was selected for the task and with the appointment his name appears under the title of Entomologist in the list of the officers of the Society for 1855, continuing until 1871. The only other department of science similarly officially recognized at the initiation of his work was that of chemistry, indicating not only the comparative importance then attached to entomology, but showing how few of the different branches of science were being called upon at even this late date to give aid to agriculture.

Ostensibly the purpose of the New York Agricultural Society in employing Fitch was that he should direct an entomological survey. In view of the criticisms directed against the technical nature of some of the productions of the Natural History Survey, he was especially authorized, in this endeavor, to give equal prominence to the economic

aspects of insects and to those of more technical interest. This he attempted to carry out, and, using his own words, his effort was really a survey of the economic entomology of New York, covering the whole range of injurious insects, as recognized by him, attacking the different agricultural crops. The merit of Fitch's writings is that they bring together existing knowledge dealing with the economy of insects, which is supplemented by his own observations. The correct identifications and descriptions of insects and his orderly arrangements of facts contrast strongly with much of the information given by practical agriculturists of his day, which was often inaccurate and therefore misleading, if not worthless.

As in New York, the beginnings of entomological work by state aid in Illinois and Missouri can be traced to the agricultural societies of these states. Early in the history of its organization the Illinois State Agricultural Society,[1] through its executive committee, declared that a considerable part of the losses by insects in this commonwealth could be saved through the labors and investigations of a competent entomologist, and that it was the duty of the legislature to provide at an early date for a thorough investigation for destructive insects for which not more than $2,000.00 per annum should be appropriated. Resolutions embodying these ideas were endorsed over a period of several years by the state agricultural and horticultural societies and the Society of Natural History, which led eventually to the appointment of a state entomologist—an office that has ever since been maintained and "which [2] stands second in point of origin and first in point of service on the list of the state agencies of scientific and economic research."

In Missouri, legislative support to entomology was brought about by the activities of the State Board of Agriculture. In outlining the needs of this organization in order to increase its efficiency and usefulness for the farming interests, its Secretary in 1866 called attention to the desirability of having at command of the Board the services of an entomologist. In the proceedings of this body in 1867 a resolution was adopted calling for the appointment of a state entomologist as well as a state geologist, and for an appropriation by the legislature of $5,000.00 per annum in order to carry out the proposed projects. Successful in its plans respecting entomology, the Board of Agriculture appointed Riley in 1868, from which year there began his masterly reports on the "Noxious, Beneficial and Other Insects of the State of Missouri."

The period commencing with Fitch's appointment in New York and the conclusion of Riley's service in Missouri is in several respects a noteworthy one in the history of entomology in the United States. Each of the workers during this period achieved great success in his

[1] Transactions of Illinois State Agricultural Society, Vol. 5, p. 34, 1861–64.
[2] Dr. S. A. Forbes, Extract from Trans. Ill. State Acad. Sci. Vol. 2, 1909.

own field, and each made notable contributions to the literature of entomology, with which their names are firmly associated. Aside from their individual efforts in their respective fields, their work considered collectively takes on impressive proportions from the magnitude and the importance of the consequences of their endeavors in behalf of agriculture. That organizations of influential farmers and of men of prominence in agriculture and public affairs made the effort to open a new era by creating sentiment to encourage and support entomology by legislative enactment possesses of itself great significance. Then, also, the appointment of these men to official positions marks the definite turning of entomology for the benefit of agriculture—the passing out of the stage of mere amateurism into a serious and widespread endeavor to make entomology really serviceable to the people. Without eulogizing the achievements of these pioneer workers at the expense of critical justice, it must be admitted that their efforts constitute a remarkable period in applied entomology, which did much to impress the public with the value of this study and give it a degree of importance and stability, which it has retained. In the development of new agencies adapted to the needs of country life, which was foreshadowed at this time by the general agitation by various state agricultural societies and other organizations of farmers for institutions for teaching and experimenting in agriculture, entomology was given recognition with other agricultural subjects.

Entomology Prominent in Federal Aid to Agriculture

In that which has preceded attention has been directed to some of the steps by which entomology was brought to the aid of agriculture and came to have rank with other departments of science in the agricultural field. In such a small compass, it has obviously been impossible to bring out many facts of interest or discuss in detail the achievements of individual workers, all of which have been sacrificed to the desire of exhibiting the major events in bold relief,—to show more clearly the great changes which have since taken place in entomology, to which my discussion now narrows. Since the days of Harris, Fitch, and Riley in Missouri, entomology has developed along distinct and in some respects, quite unique lines. This has been largely due to the far-reaching modern movements of agricultural education and investigation which has taken place with the rise and growth of the national Department of Agriculture and the land-grant colleges and associated experiment stations. By virtue of the achievements of its early workers in scientific and economic research, entomology became a constituent part of the work of these new agencies in behalf of agriculture by the establishment in the national Department of Agriculture of a Division, now Bureau, of Entomology, while in

nearly all of the agricultural colleges and experiment stations there have developed departments of entomology, which are active and influential centers in the different commonwealths for instruction and diffusion of entomological knowledge. During this period of the establishment and organization of government-aided institutions for agricultural education and research, applied entomology has made extraordinary and rapid development, which is reflected in the large accessions to the ranks of entomologists and the extent of federal and state appropriations in support of this branch of science. The result of this great increase in facilities has been organized instruction, experimentation and research in entomology, and the rise of organizations of professional entomologists, which constitute the great contributions of the present era and are the outstanding features that mark a breach with entomological work of any preceding period.

For the sake of the interest which the comparison of such statistics may afford, as well as to show the scope and differentiation in entomological activities at the present time by the aid of public funds, the following table has been prepared. The statistical statements deal with the Bureau of Entomology in the U. S. Department of Agriculture and the departments of entomology in the institutions established under the Acts of Congress of July 2, 1862, and August 30, 1890, most of which maintain courses in agriculture; and with the agricultural experiment stations which, with few exceptions, are organized under the Act of Congress of March 2, 1887. The figures also include appropriations to various state institutions besides the foregoing, which employ entomologists for instruction or research in entomology or for the enforcement of agricultural laws designed to prevent the introduction of, and destruction of, injurious insects within the confines of the different commonwealths. Owing to the complex organizations of a number of institutions it has not been possible to give exact data in all cases, but generally the amounts[1] represent conservative estimates, although in many instances they are quite accurate.

[1] These figures were obtained by means of a questionnaire. In compiling the data the estimates have been stated precisely as they were given. For purposes of accuracy the statistical accounts dealing with the work of a single state were in most instances submitted to the proper authorities for correction and approval. It was not possible to separate the amounts expended respectively for instruction, experimentation and investigation. It is believed that not all expenditures for 1912 are accounted for, as in some estimates no allowances were made for publication expenses, office help, etc. Moreover, in certain counties of a number of states large sums are raised by taxation for support of orchard and nursery inspection in addition to state appropriations, which were not taken into calculation, as are indicated in the accompanying table. The reports from several states dealing with the financial support for 1913 show great gains. The state of Pennsylvania has more than doubled its appropriations.

TABLE I.—SHOWING EXPENDITURES UNDER STATE AND FEDERAL APPROPRIATIONS FOR THE SUPPORT OF VARIOUS ENTOMOLOGICAL ACTIVITIES DURING 1912

	For instruction, investigation and experimentation	For control of bee diseases	For control of insecticides	For control of special insects	For orchard and nursery inspection and quarantine		Estimated total for insects
					Total funds	Approximate expenditures for insects	
Alabama	$3,550.00			[3]..........	$1,500.00	$750.00	$4,300.00
Arizona	5,500.00	[2]..........			6,800.00	2,660.00	8,160.00
Arkansas	2,300.00				100.00	75.00	2,375.00
California	66,091.68		$6,003.00	[3] $3,000.00	[4] 11,500.00	..........?	[7] 75,094.68
Colorado	3,400.00	[2]..........	[8]..........		12,100.00	8,107.00	11,507.00
Connecticut	3,010.09	$300.00		[3] 2,668.97	3,778.92	3,778.92	9,757.98
Delaware	[1]..........				100.00	100.00	100.00
Florida	2,700.00	[8]..........	[8]..........		3,000.00	1,500.00	4,200.00
Georgia	26,500.00				3,000.00	2,550.00	29,050.00
Idaho	[1]..........				20,000.00	15,000.00	15,000.00
Illinois	26,050.00				5,000.00	4,500.00	30,550.00
Indiana	3,700.00	3,000.00			8,000.00	6,000.00	12,700.00
Iowa	9,920.00	1,600.00			3,200.00	3,200.00	[7] 14,720.00
Kansas	17,455.00	750.00	[8]..........		10,300.00	8,155.00	26,360.00
Kentucky	3,658.00	[8]..........			500.00	333.33	[7] 3,991.33
Louisiana	3,200.00				300.00	300.00	3,500.00
Maine	2,300.00		[8]..........	[3] 30,000.00	5,000.00	1,000.00	[7] 33,300.00
Maryland	4,750.00				6,500.00	3,500.00	8,250.00
Massachusetts	8,850.00	2,000.00		[3] 250,000.00	15,000.00	12,000.00	272,850.00
Michigan	6,896.81		500.00		2,500.00	2,000.00	9,396.81
Minnesota	14,850.00				[5] 300.00	200.00	15,050.00
Mississippi	3,500.00				[8]..........	[8]..........	3,500.00
Missouri	2,730.00	1,250.00	[8]..........		1,000.00	950.00	4,930.00
Montana	5,870.00		[8]..........		14,500.00	11,600.00	17,470.00
Nebraska	6,460.00				900.00	900.00	7,360.00
Nevada	2,880.00						2,880.00
New Hampshire	3,625.00	[8]..........	[8]..........	[3] 12,500.00	[8]..........	[8]..........	16,125.00
New Jersey	4,800.00	2,000.00		[3] 25,000.00	9,000.00	6,000.00	37,800.00
New Mexico	200.00						200.00
New York	49,210.69	4,700.00	1,020.00		[5] 28,000.00	23,800.00	[7] 78,730.69
North Carolina	6,200.00				5,200.00	3,900.00	10,100.00
North Dakota	750.00				[6]..........		750.00
Ohio	15,200.00	2,700.00			21,000.00	15,750.00	33,650.00
Oklahoma	4,960.00				2,000.00	2,000.00	6,960.00
Oregon	8,500.00				[4] 12,000.00	6,000.00	14,500.00
Pennsylvania	5,000.00	3,000.00	5,000.00		[5] 35,000.00	31,500.00	44,500.00
Rhode Island	635.00	75.00	[8]..........	[3] 15,000.00	200.00	200.00	15,910.00

TABLE I.—*Continued*

	For instruction, investigation and experimentation	For control of bee diseases	For control of insecticides	For control of special insects	For and orchard nursery inspection and quarantine		Estimated total for insects
					Total funds	Approximate expenditures for insects	
South Carolina ..	$7,485.00		[8].........		[5] $2,325.00	$1,260.00	$8,745.00
South Dakota ...	3,100.00	[8].........			[6] 300.00	200.00	3,300.00
Tennessee.......	2,950.00	$1,000.00			7,000.00	6,650.00	10,600.00
Texas..........	8,200.00	2,750.00			10,594.00	9,534.56	20,484.56
Utah...........	5,495.00				[4] 5,000.00	4,250.00	9,745.00
Vermont........	[1]..........	500.00			[6].........		500.00
Virginia.........	800.00				[6] 6,000.00	5,100.00	5,900.00
Washington.....	4,350.00		[8].........		37,500.00	33,750.00	38,100.00
West Virginia ...	2,600.00				4,000.00	2,000.00	4,600.00
Wisconsin.......	4,080.00		[8].........		3,000.00	3,000.00	7,080.00
Wyoming.......	[1]..........				1,500.00	1,500.00	1,500.00
National Bureau of Entomology	317,080.00			[3]$284,840.00			601,920.00

[1] No official entomologist, and what entomological work is done is incidental to other lines of agricultural effort.

[2] In Arizona, bee inspection is supported by fees collected from bee keepers; in Colorado, is carried on without special funds.

[3] In Alabama, some of the other listed funds are spent for special work against the boll weevil; amounts listed for California and New Jersey are for mosquito control; for Connecticut, Maine, Massachusetts, New Hampshire and Rhode Island and the National Bureau of Entomology for gipsy moth and brown-tail moth control, and in the latter state in part for San José scale and elm-leaf beetle work. In Massachusetts various Park and Highway Commissions and Metropolitan Water and Sewerage Board also spent $85,900.81.

[4] In addition to amount listed large sums are appropriated by certain counties for orchard inspection; in California the amount is estimated at $1,000,000, employing 400 men for more or less time; in Oregon, $15,000 and in Utah, $10,000.

[5] In these states still larger funds are available: Minnesota, $3,000; New York, $60,000 in all; Pennsylvania, $83,000 in 1913.

[6] Supported in part or entirely by fees from nurserymen, which are not listed. In Virginia $2,000 is obtained from this source.

[7] Approximate figures even are difficult to obtain,—certainly not less than amount given.

[8] Done without special funds or handled indirectly.

The extent to which the various states were engaged in these different activities during 1912 is briefly summarized as follows: Forty-one states provided for regular instruction in entomology in the agricultural colleges, and forty-three states appropriated funds for the maintenance of experimental and investigational work. Twenty-six[1] states were engaged in research studies under the Adams Fund on about fifty-seven entomological projects, which were financed at an approximate expenditure of $44,536. For the support of nursery and orchard inspection, quarantine service, the control of insecticides, bee diseases and insects of unusual importance, all states but two made provision for funds for orchard and nursery inspection; twenty states for bee inspection, fifteen states for control of insecticides, while eight

[1] Letter of June 25, 1913, from Office of Experiment Stations.

states appropriated special funds to combat certain species of insects. The estimated amounts of money expended by the various states for the different lines of effort are as follows:

For instruction, and experimental and investigational work	$374,262.27[1]
For control of bee diseases	25,625.00
For inspection of insecticides	12,523.00
For control of special insects	338,168.97
For orchard and nursery inspection and quarantine measures against insects	245,553.81
Total amount	$996,133.05

Expenditures by the National Bureau of Entomology during 1912 are as follows:

For investigational work	$317,080.00
For control of gipsy moth and brown-tail moth	284,840.00
Total amount	$601,920.00

Estimated total expenditures by the different states and the National Bureau of Entomology for 1912	$1,598,053.05

The difficulty of obtaining accurate data regarding conditions during earlier years permits only a few comparisons, showing the increase which has occurred in the numbers of official entomologists and the gains in public funds for the support of entomology in the institutions mentioned. In 1899,[2] twenty-five men were listed as entomologists on the staffs of the experiment stations, while in 1912[3] one hundred and one individuals were recorded as serving in this capacity, being exceeded in numbers only by the workers in the departments of chemistry, horticulture and animal husbandry in the order given. Statistics bearing on the progress that has taken place in instructional work were not available but not less than one hundred and twelve persons were reported as being engaged in more or less teaching in entomology during the year in the state agricultural colleges and state universities. Accurate figures[4] exist showing the remarkable development of the national Bureau of Entomology but for the sake of brevity only a few of them have been selected. During the last year of Riley's service, which was concluded in 1894, eleven men served on the permanent staff, while five men were employed for part time. The funds for the support of the work amounted to $29,800. The force in 1912 comprised two hundred fifteen technically trained entomologists besides many

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[1] Of this amount $95,260.68 is reported as having been derived from federal funds for agricultural colleges and experiment stations, while the remaining amount represents appropriations from the different states.

[2] Experiment Station Bul. No. 1, Office of Experiment Stations.

[3] Ann. Rept. Office of Experiment Stations for 1912.

[4] Letter from Dr. L. O. Howard, Dec. 8, 1913.

other individuals who served as helpers. The budget[1] for 1913–1914 provides for an expenditure of $752,210.00.

Extension of Scope of Applied Entomology

The foregoing statistical accounts suggest many interesting and significant points for further elaboration, but only a few of them can in the brief remaining time be noted. Two impressive facts that stand out clearly are (1) the growth of entomological functions, and (2) the organization of entomological activities to keep pace with modern requirements. The increasing appreciation of the services that the entomologist can render for the public benefit has called into existence new endeavors, and further extensions of his activities are constantly being demanded. On his shoulders there has been laid the stress of unusual tasks and duties which not many years ago were neither foreseen nor expected. Indeed, things are being attempted which were not even conceived by the earlier workers as part of their possible functions. Broadly speaking, the principal fields in which most entomologists are occupied are instruction and experimentation or investigation, the line of cleavage between the latter being all too frequently indistinctly marked. Not only is the work along these lines being directed with increasing vigor and efficiency in many institutions, but the public is clamoring with greater insistence for extension activities of various sorts on a larger scale; also, for the further expansion and stiffening of inspection and control work, which now includes the certification of nursery stock for insects and plant diseases, examination of insecticides, inspection of bee diseases and control of mosquitoes and other insects that threaten the health and comfort of the community. The call for inspection and control work is especially urgent, never so urgent as today, and its importance has been perhaps underestimated and underemphasized in the past by both the federal and state authorities. The inspection of orchards and nurseries, particularly, is becoming more extensive and more complex. Once largely concerned with the San José scale, it is now directed against such pests as the gipsy moth, the brown-tail moth, the chestnut blight, the blister rust, etc., in addition to the more common and familiar species of insects and plant diseases. Because of the different seasons in which these species are most active or are most liable to be distributed, the attention of the inspection corps in some states is pretty well occupied for the entire year in this endeavor, leaving little time to devote to other duties.

To no class of entomologists have these demands afforded more serious problems than to those who are connected with the agricultural

[1] Letter from Dr. L. O. Howard, Dec. 8, 1913.

colleges and experiment stations. For in addition to their instructional and investigational work, they have attempted to direct many, if not all, of the other activites. The conditions, however, vary greatly with different states, and even with institutions in the same state, according to local demands, circumstances and financial resources. While these duties are useful and essential, the attempt to cover such a large field, especially with inadequate assistance and support, has unquestionably led to great diffusion of effort. Where efforts are so diversified no phase of the work, perhaps, suffers more than that of investigation.

Some of these difficulties that entomologists now experience will doubtless disappear as their departments become stronger and receive greater financial backing. In states where funds are more ample, these conditions are being remedied by a closer differentiation of activities. The work of instruction is gradually being separated from that of experimentation or investigation. There is also a growing tendency among entomologists of the experiment stations to subdivide their activities, by creating sections of workers within their respective departments who devote their entire energies to insects of particular crops,—as truck-crop insects, fruit insects, etc. The policy with reference to nursery and orchard inspection still continues to vary with different states. This branch of endeavor is gradually being taken over by the State Administrative Service, engaged in the enforcement of agricultural laws, although in a number of states it still remains a part of the work of the station entomologist.

Two good omens for investigational work in the future are the development of the extension efforts by the agricultural colleges and the present shifting of accent to the importance of investigation as the primary function of the station entomologist. Both of these movements are destined to bridge important gaps in existing machinery. The outstanding feature of a large part of our entomological work in the past has of necessity been its serious and practical tone. Most of the institutions we represent were established for the express purpose of devoting themselves to the solution of the problems of agriculture and of serving the needs of farming people. But if you will look carefully through any agricultural section, even the most prosperous, you will find farmers who would gladly profit by the advice of entomologists but who, for various reasons, have been unable to do so. There always has been and is a great need for a more convincing and effective demonstration of the value of certain entomological teachings. While there is a wealth of literature dealing with the economy of injurious insects, there has been more or less failure, especially marked in some lines of effort, to interpret this information and put it to practical

uses. The work now projected by the Extension Departments of the agricultural colleges, of which the County Expert project is a part, should, if conducted by men with adequate training and experience, yield results of great significance, especially along the lines of field demonstration experiments based on trustworthy and well-established facts; and in the compilation of bulletins giving useful information on the more destructive species of insects. It is obvious that if the farmers generally can be taught by this new movement to take better advantage of such assistance as well as of the information which is available, the efforts of the workers on the instructional and investigational corps would be more constantly directed to the proper duties, and to that extent their efforts should prove more productive.

Limitation of Field of Individual Effort Necessary

Speaking for the experimentalist and investigator generally, there is real need for some relief from certain of the present demands on his time and energy if he is to conduct his studies most efficiently and produce results that are comparable to the best work in similar institutions elsewhere. Experimental and investigational efforts are demanding much more concentration of effort, besides requiring a greater outlay for their maintenance. In these respects the work of today differs greatly from that of the pioneer entomologists who largely employed the methods of observation and description, and in their publications often resorted to considerable compilation. The reasons for these differences are plain. As the more simple problems are solved, new and larger ones loom in view, many of which alone afford opportunity for the full exercise and application of the worker's ingenuity and knowledge. With some problems which have been handed on unsolved from the past, experimental and observational verification is surrounded by immense practical difficulties which will not be overcome except by dogged and thoroughgoing investigation. Field experiments, formerly very limited in scope, are now being conducted on a more extensive scale. These often are not confined alone to small plats on individual farms, but they may extend over large areas, even whole counties and tiers of counties. Future efforts will place greater emphasis on the importance of coöperation. There are projects involving the control of certain injurious insects which will find their final solution when conducted as community enterprises, aimed to advance the well-being not of any particular individual or interest, but the community as a whole, which acts as a unit in carrying out an entomological measure. Such undertakings, which will more and more characterize the work of entomology in succeeding years, calls for undivided attention on the part of those engaged in such projects.

A positive point of improvement, especially in those institutions where the duties of station workers have not heretofore been clearly defined, is the encouragement to research by the support of and under the regulations of the Adams Act. This is a notable step in advance towards a sharper differentiation of the station's activities, as the enactment provides for a body of workers who are to conduct researches of a fundamental nature along lines which have been carefully considered and approved by a competent authority. This should prove a great stimulus to the prosecution of scientific investigation of the highest type in the field of agriculture, besides having the effort of giving stability to the work of investigation generally and insuring the investigators liberty to work on their problems without interference. This undertaking needs to be emphasized in the scheme of department operations, and ought to be on such a basis that it will attract the best students in entomology. The selection of suitable problems and the conditions under which investigations receiving this support can be most efficiently conducted and successfully advanced are prominent matters for consideration by every station entomologist.

Promise in New Broad Projects

In reviewing the progress of entomology in this country one cannot fail to be impressed with the enormous advantages that may be derived from a deep and systematic cultivation of new fields of knowledge. The achievements in a comparatively brief period of years demonstrate, in a most striking manner, not only what thoroughgoing study, experimentation and research may accomplish for a particular branch of science, but for the material welfare of a nation. At a time when so much thought is being directed to the conservation of our resources as a basis for individual and social efficiency, it is well to recall that the prosperity of a nation depends not alone on its natural wealth, but also on the intelligence and skill of its citizens and the capabilities and weapons they can utilize in solving the ever-increasing problems that lie in the path of civilization. The farming interests in the United States have always sustained great losses from the depredations of destructive insects. One can hardly recall any phase of agriculture of today which is not conditioned by considerations on the economy of certain species. Not only do these agents have to be reckoned with in the production of crops, but, in the light of present knowledge on the dissemination of diseases, we now know that they are important factors as regards human health and comfort, so that the farmer as well as his acres of land may fall far short of their potentialities. Some aspects of these considerations apply with equal force to our cities, especially in the more thickly-settled portions of our country,

which are confronted with some serious problems dealing with individual and social well-being because of the activities of noxious insects.

From time immemorial the inroads of injurious insects on agriculture have been regarded as inevitable handicaps for which there was little or no amelioration. But in the period in which we have lived and worked there has been marked reversal of ideas on the part of the public in their thinking about insects, which is no more strongly indicated than in the dependence upon official entomologists for advice and direction, and in the high standing of the entomological profession in the varied organizations engaged in the promotion of agriculture. The entomologists in the agricultural institutions have been foremost in calling public attention to the importance of injurious insects and in devising methods by which they may be repressed, or losses by them reduced. Besides, they are also to be credited with having forced these facts upon farmers and for inaugurating far-reaching and effective policies which have been recognized in legal enactments. The results in farm economy by the encouragement of foresight and confidence for indifference or apprehension with respect to certain destructive insects, and the elimination of a large element of chance in the production of various crops by the development of a scientific basis for remedial and repressive measures have been of inestimable value. The rapidity of development and the present financial support are convincing proofs of the vitality of entomological effort of today in this country and of its increasing economic importance in the eyes of the commercial and scientific public.

VICE-PRESIDENT WORSHAM: You have heard this splendid paper by our President. The discussion will take place at the session tomorrow morning. I wish to take this opportunity, however, to state that we are very greatly indebted to our President for this splendid paper which has been so well prepared and which contains so much thought and valuable information.

PRESIDENT P. J. PARROTT: We will now take up the regular program, and listen to a paper by Mr. F. L. Washburn on "Today's Work in Applied Entomology."

TODAY'S WORK IN APPLIED ENTOMOLOGY

By F. L. WASHBURN

(Withdrawn for publication elsewhere)

MR. F. L. WASHBURN: I wish to state that I sent copies of the statements given in this paper to different entomologists, so that they

could have an opportunity to make any corrections which they desired.

President P. J. Parrott: The next paper will be presented by Mr. W. E. Hinds on "County Organization in the Boll Weevil Campaign."

COUNTY ORGANIZATION IN THE CAMPAIGN AGAINST THE BOLL WEEVIL

By W. E. Hinds, *Auburn, Alabama*

The problem of controlling, or successfully minimizing injury by the Mexican cotton boll weevil is no longer primarily either an entomological or an agricultural problem. For several years past we have looked upon the campaign against the boll weevil as being a campaign for good farming. In the minds of many, at least, the agricultural changes which are taking place at the present time in the South, constitute much more than an agricultural revolution. We are coming to look upon the boll weevil as having brought some of the greatest blessings that have come to the South in a generation. This is true because the fight against the boll weevil has awakened the South to some of her greatest needs and is making her break loose from some of her greatest handicaps. Among these handicaps has been a one-crop system, and that crop raised principally upon a system of advances by which the crop has been mortgaged even before it is planted. The great mass of dependent, illiterate black farmers of the South, indeed, present a problem to any propaganda for progressive agriculture. The boll weevil is helping the South to see the folly of an all-cotton system and to appreciate the absolute necessity of a more diversified agriculture. The need for an increase of live stock production has been recognized and we believe that within the next generation the South is destined to become one of the greatest meat-producing sections of the United States.

Wherever it has gone, the boll weevil has helped to reduce the acreage in cotton, to reduce also the advances made upon the prospective cotton crop and to increase the planting of corn and other food stuffs and the production of live stock by which the farmer may be assured of a living in spite of the boll weevil. These are steps in the right direction; but only a beginning in their general adoption has as yet been made.

The boll weevil has given to the South, and probably to the entire United States, the Farm Demonstration Work, which has become of inestimable value in its benefits to the most progressive and open-

minded farmers especially. As outgrowths of the Demonstration work we have the Boys' Corn Clubs and Pig Clubs and the Girls' Tomato and Canning Clubs. All of these organizations have as yet, however, been unable to reach the average cotton farmer of the South. The work must be multiplied and greatly extended before we can consider the campaign successful. It must not only reach the question of increased yields and greater profits from the sum total of farming operations, which is indeed the cornerstone upon which other phases of farming improvement must be based, but there must be provided some means for securing to the rural population a leadership and an initiative that they are in most cases incapable of supplying for themselves. We also face the fact that more farmers have moved from their farms into town, in order to give their children the benefit of better school facilities, than have left the farms because of inability to make a satisfactory profit from them. Others have tired of the isolation of their country life through roads that may be impassable for several months of the year.

For these and many other reasons we believe today that the progressive agricultural movement in the South involves not only the production of crops, but also the improvement of rural school and church facilities, of rural roads and other means of communication, and such provision for community life and coöperative action as shall make rural life fully satisfactory financially, intellectually and morally.

It is to help in securing the accomplishment of such objects that we have inaugurated in Alabama a plan for County Agricultural Advisory Committees composed of a few leading spirits, in order to initiate new lines of effort and to coördinate all forces now at work in the field.

Briefly stated, the plan is to form a county advisory agricultural committee to consist of from six to ten men, representing particularly the banking, mercantile, farming and educational interests, through the appointment on the committee of at least one representative from each class; that is, a banker, a merchant doing a large advancing business, a large and successful planter or landowner—someone who is thoroughly familiar with the best agricultural practices for fighting the weevil—in most cases the county demonstration agent—and the county superintendent of education. This committee may be selected through a mass meeting, or organized under the initiative of a board of trade, or in almost any other way. The general purpose of the committee is to consider and recommend and foster all general movements looking for agricultural or rural betterment. Naturally, those things which are of immediate importance in the campaign against the boll weevil will receive first attention. The committee considers all local conditions and recommends a general plan of action and certain definite purposes for business men to keep working toward, while safe-

guarding the financial interests of both themselves and their customers. The educational campaign will be extended through the holding of beat meetings throughout the county, at which some of the most successful local men may tell what they have found from actual experience to be most feasible and profitable in that particular community. By coöperative action, the necessary agricultural and economic readjustments can be made gradually, but at a rate that will offset the increasing capacity of the weevil for damage, which usually reaches a maximum about the third year after the infestation begins. In this way the total value of farm products can at least be maintained, better agricultural practices inaugurated and prosperity most certainly increased. Labor must be retained, bad accounts avoided and foreclosures of mortgages prevented, also, if success is to be achieved in this campaign.

At its recent state convention the Alabama Bankers' Association unanimously and enthusiastically voted to support this movement and work along this line is a leading feature in the work of that association this year. There is no measuring the possible good that may result from this movement. By it the value of the Farm Demonstration Work, for instance, can probably be doubled in one year with very slight additional expenditures. Much, however, depends upon local initiative and leadership, and the leaders in this movement must have a clear vision as to the possibilities of Southern agriculture under the application of the best methods of farming with diversified crops and increased stock. They must realize the full capacity for damage of the boll weevil and must be willing to face the situation with frankness, but with unflinching courage and faith in their ability to make the fight against the weevil successfully.

President P. J. Parrott: This is certainly one of the most interesting phases of committee work on a large scale. If there is no discussion we will now take up the paper by Mr. George A. Dean on "Grasshopper Control Work in Western Kansas."

GRASSHOPPER CONTROL WORK IN WESTERN KANSAS

By Geo. A. Dean, *Entomologist, Kansas State Agricultural College and Experiment Station*

For several years the native grasshoppers, the most common species of which were *Melanoplus differentialis*, *Melanoplus bivitattus* and *Melanoplus atlanis*, had steadily increased in numbers over the western counties of Kansas, and in many of the counties did a large amount of damage to the crops. In the early fall of 1912, conditions were

very favorable for the females to oviposit, and the dry, mild winter which followed enabled fully 90 per cent of the eggs to pass the winter uninjured. In the spring the investigations of the field agents of the Department of Entomology of the Kansas State Agricultural College and Experiment Station and the district farm demonstration agents,[1] together with a large number of reports from various parts of the state, showed that enormous numbers of the hoppers were hatching out and that it was very probable that the farmers of western Kansas would experience the most serious outbreak of grasshoppers known in that part of the state, unless prompt and vigorous efforts were made to put in operation methods effective in destroying them.

Three years ago the Department of Entomology realizing that not only were the grasshoppers increasing in alarming numbers, but also that they would be doing enormous damage to the crops, stationed Mr. Francis B. Milliken,[2] assistant entomologist, in the field to study the situation and develop effective methods for the control of the hoppers and demonstrate to the farmers that they could protect their crops. In this work it was found that poisoned bran mash, the hopper dozer, and poultry and young hogs were very efficient measures for the control of the grasshoppers.

Several of the recommended formulæ for the preparation of the poisoned bran mash were used, but after thoroughly testing several of the various ones, Mr. Milliken recommended the following formula as containing the quantities of the various ingredients that proved most efficient and could be most conveniently handled:

Formula:

Bran	20 lbs.
Paris green	1 lb.
Syrup	2 qts.
Oranges or lemons	3 fruits
Water	3½ gals.

Preparation and distribution:

Mix the bran and Paris green thoroughly in a wash tub while dry. Squeeze the juice of the oranges or lemons into the water, and chop the remaining pulp and the peel to fine bits and add them to the water. Dissolve the syrup in the water and wet the bran and poison with the mixture, stirring at the same time so as to dampen the mash thoroughly.

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[1] The district farm demonstration agents are state and government men. They are farm advisers and work under the direction of the Kansas State Agricultural College.

[2] Mr. Francis B. Milliken was assistant entomologist of the Kansas Experiment Station for the two years previous to September 1, 1912, and is now with the Bureau of Entomology, United States Department of Agriculture.

The bait when flavored with oranges or lemons was found to be not only more attractive, but also more appetizing, and thus was eaten by more of the grasshoppers.

The damp mash or bait should be sown broadcast in the infested areas early in the morning, or about the time the grasshoppers are beginning to move about from their night's rest. It should be scattered in such a manner as to cover five acres with the amount of bait made by using the quantities of ingredients given in the above formula. Since very little of the bran mash is eaten after it becomes dry, scattering it broadcast in the morning, and very thinly, places it where the largest number will find it in the shortest time. Sowing it in this manner also makes it impossible for birds, barnyard fowls, or live stock to secure a sufficient amount of the poison to kill them. On alfalfa fields, in order to secure the best results, the bait should be applied after a crop has been removed and before the new crop has started. Inasmuch as the poisoned bait does not act quickly, it will be from two to four days before the grasshoppers are found dead, and these will be more numerous in the sheltered places. It does not require much of the poison to kill them. Even a small portion from one of the poisoned flakes will be sufficient to cause death.

Last spring, early in the season the Department of Entomology sent out advance notices and circulars of warning, stating how favorable the conditions had been for the female grasshoppers to oviposit, and how the mild, dry winter had enabled fully 90 per cent of the eggs to pass the winter uninjured. This information was published in all the farm journals and nearly every daily and county newspaper in the state. Later, the department not only sent out another warning, stating that the hoppers had hatched out in enormous numbers, and that they were already seriously injuring crops, but also sent two men to demonstrate the practical methods of control. Three district farm demonstration agents were also busy in urging the farmers to prepare to fight the grasshoppers that were already devouring their crops. Many farmers, and in one place the entire county, put into operation the methods recommended and profited thereby, but the great majority either paid no attention to the warning or failed to put the methods of control in operation at the opportune time; that is, while the grasshoppers are young or are just migrating into the cultivated fields, and thus they soon found themselves facing the most serious outbreak of grasshoppers known in their part of the state. They were now compelled either to destroy the almost fully grown hoppers or allow them to completely devastate their crops, kill their orchards and destroy their shade trees. The farmers were now crying for help. Mr. G. E. Thompson, the district farm demonstration agent of Southwest Kansas,

succeeded in getting Ford County to organize for a systematic fight. The county commissioners realizing the seriousness of the situation agreed to appropriate money out of the county funds to furnish free poisoned bran mash for every farmer in the county. The county was organized through the township trustees, every trustee being held responsible for the work in his township. The governor of the state was requested to urge upon the county commissioners of the adjoining county to coöperate in the work. Monday, July 14, was set as the "grasshopper day." The county commissioners had distributed over the entire county the following printed circular:

GRASSHOPPER FIGHT NEXT MONDAY

"In view of the alarming numbers in which grasshoppers are appearing in Ford County, and the untold damage which they are causing to growing crops, the board of county commissioners has appointed Monday, July 14, as the date on which to make a united and determined effort throughout all the townships of the county to destroy the pests as completely as possible.

"In order to enlist the help of every farmer in the county, in one big effort to exterminate the grasshoppers on that day, we have directed the trustees in every township to purchase at county expense the supplies which are needed in his township for poisoning the grasshoppers, using the formula which the State Agricultural College has found to be most effective.

"We appeal to every farmer, every landowner and every tenant to take up this matter at once with the trustee of their township who will furnish all the supplies and have charge of the work in that township. The situation demands that we deal with this pest promptly and effectively. Please get in touch with your trustee at once by telephone or otherwise, find out where you are to go to get the materials and interest all your neighbors in the campaign.

"Get your supplies in time so that you will be ready to spread the bait early Monday morning before the grasshoppers have begun to move.

"This is one of the most serious situations Ford County has faced for several years. We must have every farmer in the field early next Monday morning if we get the best results. All that remains for the farmer to do is to go to the trustee and get the materials which the county is furnishing and spread them on the infested fields. Please give every assistance in your power.

G. W. ARTWEIN, W. J. DAVIES, C. R. ATEN, *County Commissioners.*"

This summons was electric in effect. It was as if an army were moving on the country. Farmers who had stood helplessly by watching hordes of grasshoppers devour field after field and even orchards and shade trees, now assumed a fighting attitude. The plan proposed by the demonstration agent met with the approval of all. Every township trustee was to call by telephone or see personally every farmer in his district and tell him where to call for his portion of the poison. Distributing points were established at four towns in the county. The poisoned bran mash used was to be made and distributed according to the plan recommended by the Department of Entomology. It was

the poisoned bran mash that had proved so successful the two previous summers. Four days before the poison was to be distributed the writer took the field personally to conduct the campaign.

So well organized was the work, and so perfect the coöperation, credit for which should be given Mr. G. E. Thompson, the district demonstration agent, that two days before the time set as "grasshopper day" the county commissioners had the material on hand, and the township trustees had their forces marshaled and ready for the fight. Within the next three days supplies were distributed to the farmers sufficient to prepare nearly one hundred tons of poisoned bran mash. All day long hundreds of farmers came for their allotment of the material. One or two representatives from the Agricultural College or the University of Kansas were at each place to explain how to mix and distribute the poison. The Paris green and bran were mixed at the distributing stations, but the syrup, oranges and water were not to be added until it was ready to put out in the field. A printed circular describing the method of preparing the poisoned bran mash, together with the method of distribution, was given to every farmer, so if he forgot the instructions of the college men he would have the directions in the circular. The circular also described in detail the other methods of control. A county official checked out the poison at each place. A two hundred-pound allotment was given each farmer, providing, of course, he had use for that amount. Of course this amount was not sufficient for the farmer who had several hundred acres of crops to protect. However, the county officials felt that it was enough fully to demonstrate to him that the poison was efficient, and after he was convinced the hoppers could be destroyed and his crops saved, he would be willing to buy additional material for distribution over the remaining fields of his farm. Although the writer knew the poisoned bran mash had proved successful where it had been used on a small scale the two previous summers, and had persuaded the farmers and county officials that it was no experiment but just a piece of demonstration work, he could not help feeling anxious as to what the result would be. Over one thousand farmers in a single county had taken home the poison. Reporters from several of the leading daily papers were there to write up the result. Several other counties were waiting to either organize to distribute poisoned bran mash, or join in the criticism of the college. A number of persons, such as you always find when doing work of this sort, were waiting for an opportunity to severely criticise the work. Meanwhile the farmers had distributed one hundred ton of poison. Thus Ford County and all of us rested and waited. The grasshoppers ate and so ravenous were they for the poisoned bait that they even left their

choicest green food. In two days the poison had done its work. Investigations and reports from all over the county showed that from 60 to 70 per cent of the grasshoppers had been killed by the first application. Counts made in alfalfa fields of average infestation, showed from one hundred and fifty to two hundred and fifty dead grasshoppers per square foot. In many places under a single tree there was a peck of dead hoppers, and along hedges the ground directly under the hedge was completely covered, and in some places they were actually piled up two and three deep. In other words, the results were far better than anyone could have expected.

The grasshopper control work did not stop with Ford County. It was now an easy matter to organize, and eleven other western counties followed the example of Ford County in quick succession. In each of these counties the ingredients were furnished by the county and the same method of organization was used. The results were equally as good, and in some cases better. For instance, in Pawnee County where one hundred and twelve tons of the poisoned bran mash were distributed, fully 80 per cent of the grasshoppers were killed, and in Ellis County where one hundred and sixty-eight tons were distributed, one hundred and twenty tons of which were distributed in a single day, almost 90 per cent of the grasshoppers were destroyed.

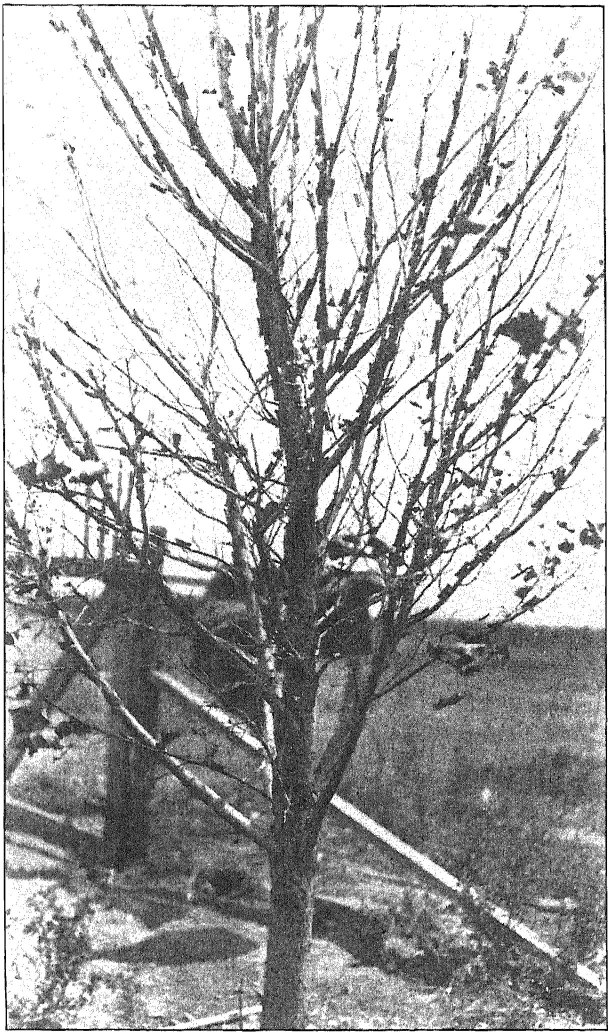
The following report of the amount of poisoned bran mash used in the grasshopper control work is taken from the reports of the county officials:

AMOUNTS OF POISONED BRAN MASH USED

County	Area in sq. mi.	Amount furnished by the county—Tons	Amount furnished by individuals—Tons	Total—Tons
Ford	1,060	98		98
Kearny	848	28		28
Finney	1,280	70		70
Hodgeman	804	28		28
Gray	852	60		60
Edwards	600	28	28	56
Pawnee	744	74	38	112
Ellis	895	168		168
Trego	900	14		14
Rawlins	1,080	38	20	58
Scott	720	28		28
Gove	1,080	54		54
Other N. W. counties	600		60	60
Other S. W. counties	500		40	40
Total	11,963			874

Fig. 1. Grasshoppers destroying a cornfield; only the bare stalks remain.

Fig. 2. Farmers getting their allotment of poisoned bran mash, Dodge City.



Carolina poplar defoliated by grasshoppers.

Such excellent coöperation was had from all the farmers and county officials and so well organized was the work that it lasted only two weeks. Six representatives from the Agricultural College, three district farm demonstration agents, one representative of the Bureau of Entomology, United States Department of Agriculture, [1] and four representatives of the University of Kansas, coöperated in the work.

The entire work was an excellent example of coöperation, and demonstrated what can be done when farmers, merchants, bankers, millers, college men, farm demonstration agents, government men, and county officials get together.

Although the farmers in western Kansas experienced last summer the most serious outbreak of grasshoppers known in that part of the state, they demonstrated that they were equal to the occasion. After they were once convinced they were prompt in organizing, and by putting into operation the methods of control recommended by the Agricultural College, they were successful in destroying the grasshoppers. At the close of the season the entomologists and the farm demonstration agents made a careful examination of the grasshopper situation and were convinced that there were fewer grasshoppers in western Kansas than there had been for many years. In fact, when we consider that the farmers of western Kansas fed to their grasshoppers almost a thousand tons or two million pounds of poisoned bran mash, it is no wonder that there is a scarcity of grasshoppers. From 60 to 80 per cent of the hoppers were killed by the poisoned bran mash. The remaining grasshoppers were so left to the mercy of the parasitic and predaceous enemies that only a few of them escaped.

President Parrott: This paper has been very interesting. We have another on the same subject by Prof. S. J. Hunter, which we will have before opening the subject for discussion. [The author submitted the following in place of the verbal report. Ed.]

GRASSHOPPER CONTROL IN THE SOUTHERN DIVISION OF KANSAS

By S. J. Hunter and P. W. Claassen, *University of Kansas, Lawrence*

Seventeen years ago the first problem presented to the senior author when first he became officially associated with the University of Kansas was the native grasshopper problem in western Kansas. This

[1] The writer desires to acknowledge the valuable coöperation of the Bureau of Entomology, United States Department of Agriculture. Mr. Harrison Smith, assistant entomologist, United States Department of Agriculture, helped very much in organizing counties in Northwest Kansas.

was in a letter from Secretary Coburn of the State Board of Agriculture transmitting a number of letters from alfalfa growers in the western part of the state. Accordingly the department fitted out an expedition which spent three seasons in camp in the alfalfa fields of western Kansas. Results of this work were given in three bulletins of the department of entomology.[1]

Discing of alfalfa in early spring was here first advocated as an effective means of destroying the grasshopper eggs and as well increasing the forage yield. From time to time as occasion required this problem has been followed. On June 6, 1913, Mr. A. J. Spangler, then assistant state entomologist, began work in Ness, Ford and Gray counties, giving special attention to the fungous disease then prevalent among the nymphs. Mr. Spangler continued his experimental work on this until he resigned July 1, 1913, to become state inspector of Minnesota, and was immediately succeeded by the junior author of this paper.

The University has responded to requests for entomological work from all parts of the state from 1872, at which time Dr. Snow was made chairman of the entomological commission of the Kansas Academy of Science, until 1907. In this latter year the state legislature created an entomological commission, the scope of whose work is in accordance with Section 4 of the Law creating that commission as follows: "That it shall be the duty of said state entomologists, under the control of the state entomological commission, to seek out and suppress pernicious insect pests and injurious and contagious plant diseases hereinbefore mentioned as destructive to the horticultural and agricultural interests of this state, and conduct experiments when necessary to accomplish that end.[2]

This commission shortly after the enactment of the law divided the state as shown in a map published in the first annual report of the

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[1] Dept. Contb. No.

31–1897—The More Destructive Grasshoppers of Kansas. Bul. Dept. of Entomology, Oct., pp. 1–111 pls. I–IV. F. H. Snow and S. J. Hunter.

35—Parasitic Influence on Melanoplus. K. U. Quarterly, VII, pp. 205–210, Oct. figs. S. J. Hunter.

38–1899—Alfalfa, Grasshoppers, Bees; Their Relationships. Bul. Dept. Entomology, pp. 1–164, pls. I–XIII, figs. 1–59. S. J. Hunter.

In addition to these, three taxonomic papers were prepared as follows:

47—The Melanopli of Kansas. Part I, Psyche, vol. IX, pp. 63–64, June, 1900. S. J. Hunter and W. S. Sutton.

48—The Melanopli of Kansas. Part II, Psyche, vol. IX, pp. 76–78, July, 1900. S. J. Hunter and W. S. Sutton.

49—The Melanopli of Kansas. Part III, Psyche, vol. IX, pp. 88–9, August, 1900. S. J. Hunter and W. S. Sutton.

[2] Chapter 386, Kansas Session Laws of 1907, Sec. 4.

commission for 1907 and 1908. Since that time all the University's entomological work along economic lines has been confined to the part of the state assigned to the state entomologist of the University of Kansas by the entomological commission.

Therefore, from the numerous requests received this season from counties in the University's district, it was evident that vigorous measures were being called for. Accordingly, the authors formulated a campaign in conjunction with the county commissioners with the coöperation of the following members of the department force: Assistant Professor Hungerford, Assistant W. T. Emery, Field Assistant A. E. Mallory, Assistant Dwight Isely, and Professor W. B. Wilson, head department of biology, Ottawa University, an appointee of the commission for this work. All these men are university graduates of several years standing and with two or more years' experience in entomological field work.

The organization of the counties in the University's territory was accomplished by holding a mass meeting called by the county commissioners at which one or more of the University's entomologists were present to give details of the organization and direct the work.

At this meeting a certain day was designated as Grasshopper Day when every man in the county was enlisted in the fight. The township trustees of each township were instructed to issue to each farmer a certain amount of the poison and the University entomologists were there to direct its application and record results. Practically every farmer in these counties availed himself of the opportunity to destroy the grasshoppers on his place in this way.

The formula used is given below. Since the formula used by Professor Dean of the State Agricultural College, with whom we worked in two counties, differed from ours as first published in the use of oranges instead of lemons and an additional amount of syrup, we, at his suggestion, to avoid confusion among the farmers, added the oranges to make the formulas uniform. Our experiments, however, show that the use of lemons is 40 per cent more effective than the use of oranges. In fact we have found that vinegar has proven as effective as oranges. The use of oranges shows no appreciable difference in the attractiveness of the bait, as compared with plain bran mash.

The commissioners of the various counties concerned entered heartily in this work and not only furnished the poison but furnished circulars, samples of which may be obtained by interested parties on application to the author.

In addition to this the University distributed 5,000 circulars of instructions over its territory.

The following is the formula which was recommended:

I

$2\frac{1}{2}$ lbs. Paris Green or White Arsenic.
50 lbs. Bran.
Mix these dry.

II

6 oranges, or lemons, chopped up fine, rind and all.
4 quarts syrup.
5 gallons water.
Mix these tnree together thoroughly.
Mix I. and II., then add sufficient water to make a wet mash.

CAUTION:—Do not add water until the day the poison is to be distributed.

Early in the morning between 5 and 7 o'clock this poisoned bran should be scattered broadcast in the infested areas. It is of great importance to get the poison out early as the hoppers eat it better when first beginning to feed.

SUMMARY OF RESULTS

County commissioners of the following counties coöperated on the above plan and furnished the several amounts set opposite their names:

Finney, Garden City—4,000 pounds Paris green—40 T. bran.
Gray, Cimmarron—1,700 pounds Paris green—17 T. bran.
Hodgeman, Jetmore—1,000 pounds Paris green—10 T. bran.
Ford, Dodge City—4,500 pounds Paris green—45 T. bran. (The Santa Fé, the Federal Bureau, the College, and the University worked together here.)
Scott, Scott—1,000 pounds arsenic—10 T. bran.
Kearney, Lakin—2,500 pounds Paris green—25 T. bran.
Edwards, Kinsley—(The same forces worked here as in Ford County).
Pawnee, Larned—(Professor Dean of the college took full charge here).
Meade County—1,500 pounds Paris green—30,000 pounds bran.

In the following counties the entomologists of the University gave individual assistance to the farmers:

Hamilton,	Ness,
Wichita,	Lane,
Pratt,	Stafford.
Barton,	

The morning was found to be the best time to apply the mixture. It does not dry as fast then and the grasshoppers are more eager for food, and are, therefore, more easily attracted to it. When scattered broadcast, using three to five pounds of the mixture to the acre, the danger of poisoning fowls is eliminated.

Chickens eating the poisoned hoppers do not appear to be affected.

The poisoned hoppers do not seem to take enough poison to affect the cannibalistic brethren who are wont to devour their poisoned kind.

Actual counts showed that after the bran mash once became dry it lost its attractiveness and thereby its effectiveness. This is another reason advanced for early morning application.

Since under ordinary weather conditions the bran dries out in about two hours, distributing the mash in little balls or piles was tried. It was found, however, upon experiment, that the sowing of the bran mash broadcast was more effective for the following reasons:

a. It eliminates all danger of poisoning fowls or stock.

b. Covers more than twice as much area and thereby reaches more hoppers.

c. After the outer surface of the bran-mash ball has once become dry it is not eaten even though the inside may still be moist.

d. With the same amount several applications may be made at intervals of two to four days thereby reaching more hoppers.

Observation counts showed that 40 to 60 per cent of the grasshoppers were killed with one application of the poison. A second application destroyed from 70 to 80 per cent of the grasshoppers.

Investigations in comparison with checked fields after the 25th of September showed that there were less than half as many living hoppers on the field where poison had been scattered than on checked fields where no poison had been applied.

Sarcophagid parasites were unusually active throughout the region.

The locust fungus was unusually active in four counties in the early spring but with the dry weather it practically disappeared. All attempts at artificial distribution were without avail.

It would seem almost impracticable to distribute poison in a green alfalfa field where there is abundance of feed for the hoppers and yet, from figures based on actual counts, about two hundred and forty thousand grasshoppers were killed per acre with one application right in the midst of a large green alfalfa field. Poison for this experiment was scattered broadcast through the field, using four to five pounds to the acre at an actual cost of not over twelve cents per acre.

A more effective means, however, is the mowing of the field, leaving strips of standing alfalfa four to six feet wide and about seventy-five yards apart. The grasshoppers soon collect in these strips and are thus readily poisoned with small amounts of the bran mash or easily caught with the hopperdozer.

By the use of these means one of the largest alfalfa growers in the southwest was able to harvest three crops of alfalfa before the first of August where in a check field nearby only one crop was harvested in the same time and that the first crop.

Experimental Work on Attractiveness of Various Poison Mixtures

Experiments to determine the attractiveness and effectiveness of a number of poison baits were made. The sites chosen for such experiments were bare of vegetation but rich in green vegetation twenty-five to one hundred feet away.

For example beds of dried up ponds and unused bare irrigation ditches were used. In such situations the grasshopper could readily be observed descending from the food plants and marching directly to the poison.

The general mixture of bran, Paris green, and syrup was used, lemon, anise oil, stale beer, and vinegar were added to separate portions respectively. On further experiment, plain bran and Paris green and plain bran with syrup were used to check results

The object of these experiments was to find, if possible, a cheaper product to take the place of the expensive lemon, using vinegar, if possible.

Beginning with the lemon mixture and following it by anise oil, stale beer, and vinegar mixtures respectively, these were put out separately in a series of portions, about a teaspoonful in a place. Counts were then made of the number of hoppers attracted to the various baits and recorded as follows:

Experiment 1

Showing number of hoppers attracted to individual baits

These counts were made at intervals of twenty to thirty minutes.

	Lemon			Anise Oil			Stale Beer			Vinegar		
Count No.	1	2	3	1	2	3	1	2	3	1	2	3
Pile No. 1	11	15	3	1	8	1	3	7	0	1	7	0
Pile No. 2	8	14	2	4	11	2	5	7	0	4	6	0
Pile No. 3	8	6	0	1	6	3	3	4	0	4	3	0
Pile No. 4	4	9	7	3	3	2	3	2	0	3	2	0
Pile No. 5	7	4	1	3	1	0	3	2	0	2	4	0
Pile No. 6	5	4	0	4	1	1	3	1	0	5	4	1
Pile No. 7	6	6	0	6	4	0	2	0	0	2	5	0
Pile No. 8	2	8	1	3	2	1	3	3	0	2	2	1
Pile No. 9	12	11	2	3	1	0	6	0	1	1	1	1
Pile No. 10	8	3	7	3	3	1	2	4	0	0	1	0
Pile No. 11	2	6	5	5	5	6	2	0	4	2	4	10
	73	86	28	36	45	17	35	30	5	26	39	13

Total number of hoppers attracted by various baits:

Lemon, 187 Stale beer, 70
Anise oil, 98 Vinegar, 78

The third count shows the comparatively small number of hoppers attracted after the bait had dried out.

Experiment 2

This experiment was made in the alfalfa stubble along the edge of a field that had not yet been cut.

The table again shows the number of hoppers attracted to individual baits.

Counts made at intervals of twenty to thirty minutes.

	Lemon		Anise Oil		Stale Beer		Vinegar		Plain Mixture		Plain Syrup	
Count No.	1	2	1	2	1	2	1	2	1	2	1	2
Pile No. 1	3	1	5	0	3	1	4	1	6	2	4	1
Pile No. 2	12	4	6	3	1	3	2	0	9	4	7	0
Pile No. 3	5	4	3	1	6	4	4	1	4	4	8	2
Pile No. 4	6	4	8	7	6	2	4	0	4	1	6	1
Pile No. 5	11	2	6	1	4	4	3	2	9	1	6	2
Pile No. 6	9	3	8	3	3	0	2	1	2	1	7	3
Pile No. 7	7	5	5	3	3	2	4	4	4	3	7	1
Pile No. 8	10	5	5	4	5	1	1	1	6	2	5	3
	63	28	46	22	31	17	24	10	44	18	50	13

Total number of hoppers attracted by various baits:

Lemon, 91	Vinegar, 34
Anise oil, 68	Plain mixture, 62
Stale beer, 48	Plain syrup, 63

The plain mixture column contains only bran, Paris green, and water. The last column contains syrup in addition to the plain mixture. These were put out as checks.

Experiment 3

This experiment was made at same time and of the same mixtures as No. 2, but placed on bare ground near green vegetation.

	Lemon		Anise Oil		Stale Beer		Vinegar		Plain Mixture		Plain Syrup	
Count No.	1	2	1	2	1	2	1	2	1	2	1	2
Pile No. 1	4	11	7	8	3	3	9	4	8	3	7	1
Pile No. 2	12	6	7	2	3	4	3	2	13	4	3	3
Pile No. 3	6	4	7	7	5	4	8	6	9	3	8	2
Pile No. 4	5	1	9	4	3	2	4	3	6	6	3	4
Pile No. 5	2	3	3	0	3	2	3	2	3	4	4	2
Pile No. 6	8	4	6	4	6	3	7	3	12	5	4	3
Pile No. 7	16	11	6	6	3	2	10	2	7	5	3	3
Pile No. 8	12	8	8	5	3	4	5	1	4	6	9	5
	65	48	53	36	29	24	49	23	62	36	41	23

Total number of hoppers attracted by various baits:

Lemon, 113	Vinegar, 72
Anise oil, 89	Plain mixture, 98
Stale beer, 53	Plain syrup, 64

Experiment 4

These mixtures were put out in the center of an irrigating ditch, eight to ten feet away from all vegetation.

	Lemon			Anise Oil			Stale Beer			Orange			Vinegar			KCn		
Count No. 1	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3
Pile No. 1	10	9	6	1	6	5	9	8	8	3	5	2	1	4	7	0	0	0
Pile No. 2	5	5	3	4	6	3	3	4	6	4	1	2	4	6	2	0	0	0
Pile No. 3	9	8	3	4	2	6	2	2	3	6	9	3	1	6	3	1	1	0
Pile No. 4	7	4	2	6	4	1	2	3	1	7	2	3	7	5	1	0	0	0
Pile No. 5	2	1	1	6	9	6	2	2	4	7	5	3	3	4	5	0	0	1
Pile No. 6	8	14	9	2	3	2	15	7	10	4	2	2	14	6	5	0	0	0
Pile No. 7	12	8	8	8	6	3	15	7	5	15	4	5	17	9	7	0	0	0
Pile No. 8	23	14	7	10	12	5	12	14	5	21	10	1	10	8	5	0	0	0
Pile No. 9	14	9	7	7	4	5	21	7	5	5	4	6	26	14	6	0	0	0
Pile No. 10	8	18	4	10	13	2	17	13	5	15	5	3	11	5	3	0	0	0
Pile No. 11	26	7	6	17	11	2	12	4	3	3	10	4	2	15	4	0	0	0
Pile No. 12		18	9		10	4		16	8		7	5		5	4		1	1
Pile No. 13		8	7		4	2		8	2		8	3		6	2		0	1
Pile No. 14		6	4		11	5		10	1		8	3		9	4		0	0
Pile No. 15		7	5		5	3		7	3		5	2		7	3		0	0
Pile No. 16		8	5		8	3		8	5		3	9		8	1		0	0
Pile No. 17		15	8		4	2		15	2		4	3		2	1		0	0
Pile No. 18		18	9		9	4		12	6		7	6		4	2		0	0
Pile No. 19		16	3		4	2		10	10		11	2		4	2		0	0
	124	193	106	75	131	65	110	157	92	90	110	67	95	127	67	1	2	3

Total number of hoppers attracted by various baits:

Lemon, 423	Orange, 267
Anise oil, 271	Vinegar, 284
Stale beer, 359	KCn, 6

Experiment 5

	Lemon		Anise Oil		Stale Beer		Orange		Vinegar		Plain		Plain Syrup	
Count No. 1.	1	2	1	2	1	2	1	2	1	2	1	2	1	2
Pile No. 1	4	4	6	1	11	1	3	1	6	2	12	2	9	0
Pile No. 2	6	4	5	2	5	3	2	1	7	1	11	2	8	4
Pile No. 3	10	6	4	2	8	3	2	3	3	2	8	3	13	2
Pile No. 4	4	5	4	0	6	3	2	1	2	1	2	1	3	2
Pile No. 5	5	3	6	2	5	5	4	1	6	4	3	2	10	3
Pile No. 6	7	4	7	2	6	9	7	2	11	2	5	2	8	2
Pile No. 7	13	5	6	2	2	2	6	2	4	1	13	4	16	6
Pile No. 8	12	5	10	5	3	2	2	2	5	2	8	1	4	3
Pile No. 9	9	1	8	3	8	5	3	4	3	5	4	1	7	1
Pile No. 10	18	8	4	3	5	1	2	4	2	0	19	6	16	7
Pile No. 11	11	4	1	3	2	2	7	5	2	7	5	1	7	1
Pile No. 12	8	2	3	5	11	5	7	0	14	0	5	4	6	2
Pile No. 13	16	5	7	4	5	1	9	4	6	1	4	2	5	1
Pile No. 14	5	2	3	1	10	1	10	3	6	1	7	3	6	3
Pile No. 15	2	5	8	2	9	6	7	4	5	3	9	3	14	1
Pile No. 16	3	2	3	0	4	2	4	1	9	1	4	5	4	0
Pile No. 17	5	1	4	5	6	2	2	2	1	2	6	2	9	2
	137	66	89	42	106	53	79	40	91	35	125	44	145	40

Total numbers of hoppers attracted by various baits:

Lemon, 203	Vinegar, 126
Anise oil, 131	Plain mixture, 169
Stale beer, 159	Plain syrup, 185
Orange, 119	

In this count the additional ingredients added to plain bran poison mash made no appreciable difference in the attractiveness of the bait. The potassium cyanide was tried in place of Paris green, but proved to be a complete failure. The hoppers would not eat the bait containing KCn.

Summary of Preceding Data

	Total number of Portions of Bran Put Out	Total Number of Hoppers Attracted	Average Number of Hoppers for Each Pile of Bran
Lemon	148	1,016	6.8
Anise Oil	148	654	4.4
Stale Beer	148	680	4.59
Vinegar	148	594	4.0
Orange	93	386	4.1
Plain bran	66	329	4.9
Plain syrup	66	312	4.8

The lemon, therefore, seems to be about 26.5 per cent more effective than any of the other ingredients tried. As the foregoing experiments show, however, very good results can be obtained with the plain bran Paris green mash alone.

All the above experiments show that the grasshopper has a keen sense of smell and is easily attracted to the bait put out for it.

In one instance a little of the mixture (about a teaspoonful) containing the lemon in it, was placed in the middle of the road where no vegetation was present and the distance measured from which the hoppers were attracted. Several minutes after the bait had been put out, the hoppers were seen leaving the thistles and crawling for their newly prepared breakfast. Soon the congregation around the "table" numbered between sixty and seventy. A photograph (see plate 3, fig. 1) was taken of the "boarders coming for breakfast" but many of them were scared away while a number of the others turned "right about face."

The distance between the bait and a large thistle from which twelve to sixteen hoppers came was then measured and found to be fifty feet. It seems remarkable that the sense of smell should be so keenly developed in the grasshopper.

METHODS OF OVIPOSITION BY M. DIFFERENTIALIS

The usual text and figures have shown a recurved position of the abdomen when illustrating the method of oviposition in grasshoppers. Milliken,[1] however, has described the position of *M. bivittatus*, *D. carolina*, and *S. shoshone.* In his accompanying figure, the abdomen and cavity is shown protruding greatly beyond the tips of the tegmina. This is also described by W. D. Hunter.[2]

In an examination of twenty-one *differentialis* made during oviposition by the junior author, no abdomen or excavation was found to extend perceptibly back of the tegmina.

The accompanying plate 4 serves to illustrate the various positions assumed by *M. differentialis* during oviposition.

It has been our observation that the *differentialis* locust does not begin to oviposit in this latitude before the first of October and this season was no exception. In the ground covered by short buffalo grass along the roadsides, or by paths through the alfalfa fields, are the places selected for oviposition by *M. differentialis.*

MR. HENRY SKINNER: I would like to inquire whether the use of oranges or lemons was original at this time, and I would also like to know if Professor Dean can give us any estimate of the value of the lemons and oranges in the mixture.

MR. GEORGE A. DEAN: The use of fruit juices is not original with the Kansas Experiment Station. It had previously been tested in California, but its use was not general. When we tried it two or three years ago we were convinced that it was very efficient. In case it is left out of the bran mash about 75 per cent of the efficiency of this material is lost. Fruit juices seem to attract the grasshoppers so that they will feed on the poisoned bait. They will leave green corn and feed on the poisoned bran mash. It seems to be more appetizing.

MR. R. A. COOLEY: What kind of syrup is used?

MR. GEORGE A. DEAN: I prefer common glucose syrup. We also get a considerable amount of beet sugar syrup from Colorado.

MR. WILMON NEWELL: I would like to ask whether or not you found this bran mash effective where the infestation was heavy and where the hoppers had an abundance of food?

MR. GEORGE A. DEAN: In a great many places the hoppers were in the corn and fresh food was very plentiful, yet they would leave the corn and also alfalfa and feed on the poisoned bran mash.

MR. E. P. FELT: I would like to ask if the weather conditions had any material influence in increasing the efficiency of the poisoned

[1] This Journal, Vol. 5, No. 2, page 232.

[2] California Bul. 170, 1905.

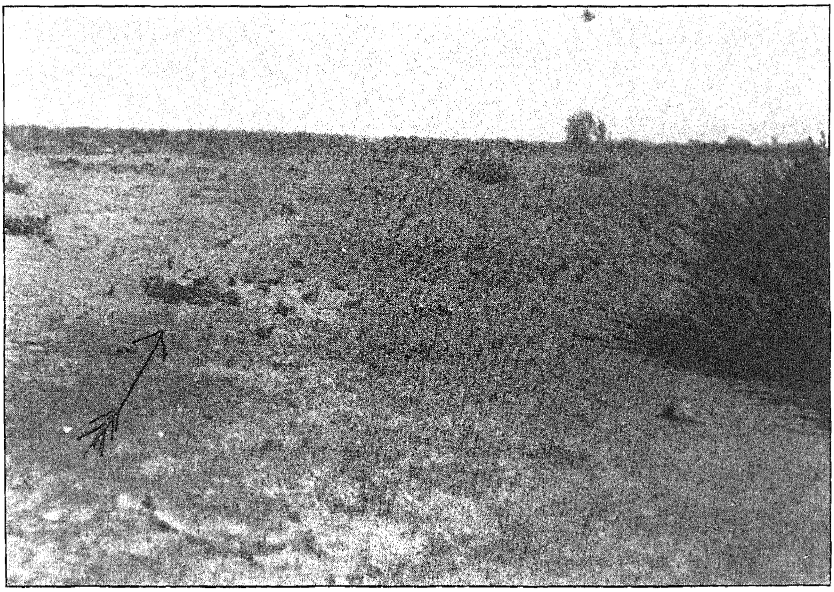


Fig. 1. The arrow points to a mass of grasshoppers attracted to a teaspoonful of the lemon poison. Others on the way turned back on the approach of the photographer.

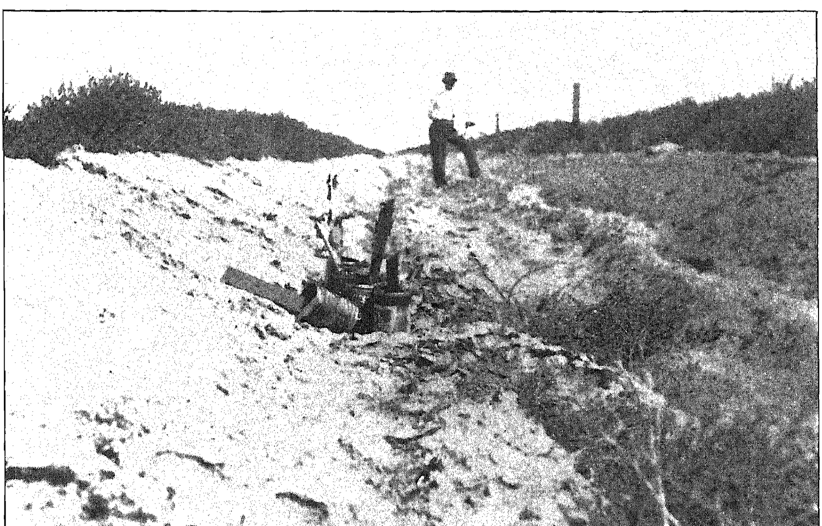
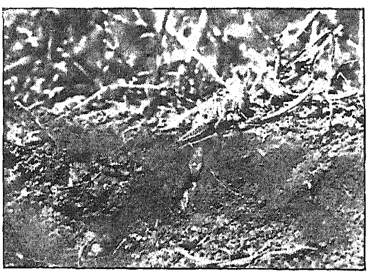


Fig. 2. Grasshoppers descending the sides of an unused irrigation ditch to feed on remnants of poison in cans used for mixing the poison bait. Photo by P. W. Claassen.

1

2



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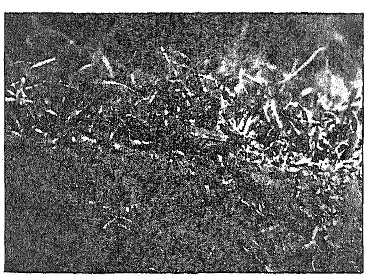


5

6

Figs. 1–6. Photographs showing mode of oviposition in *Melanoplus differentialis*. Note that in no case does the abdomen or cavity extend back of tegmina. These insects were instantly killed in act of oviposition with prussic acid and lateral view exposed for photograph. Photograph by P. W. Claassen.

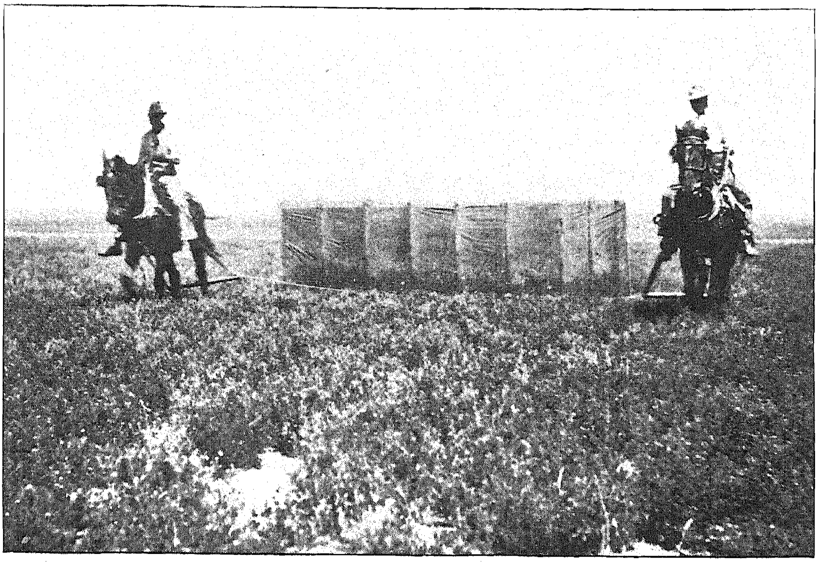


Fig. 1. Hopperdozer at work.

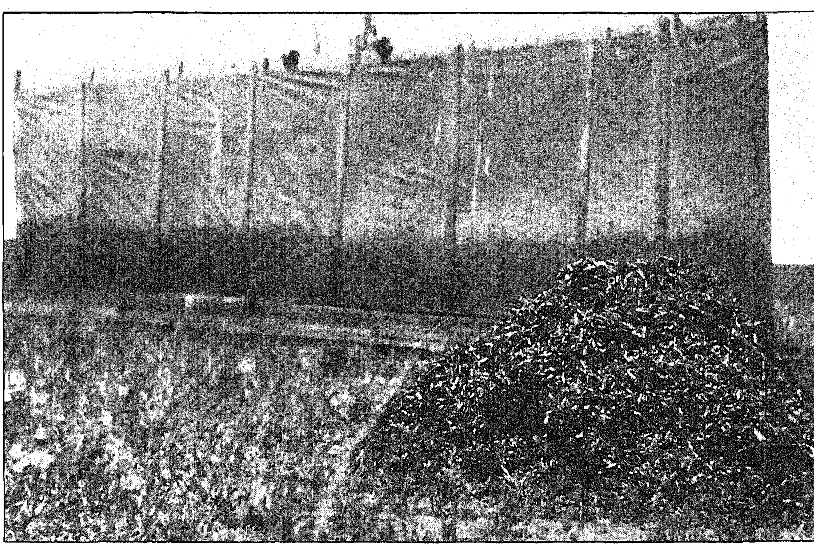


Fig. 2. One catch of grasshoppers. Photo by P. W. Claassen.

bran mash. Would it have been equally efficient if the foliage had been succulent?

MR. GEORGE A. DEAN: The drouth conditions in my opinion aided greatly. These grasshoppers had come two or three miles and were very hungry. It was very hot in Kansas and they sought shady places. They preferred to do their feeding in the shade and the drouth conditions aided greatly in getting the grasshoppers to the poisoned bran mash in shady places.

MR. J. G. SANDERS: Has a test been made of artificial or synthetic orange flavor? This material is very cheap.

MR. GEORGE A. DEAN: I have used extract of lemon and other things, but believe that if the orange fruit is ground up with the peelings, that it is more attractive to the hoppers.

PRESIDENT P. J. PARROTT: The next paper on the program is by Mr. Z. P. Metcalf on "Report of Field Work on the Southern Corn Bill Bug."

REPORT OF FIELD WORK ON SOUTHERN CORN BILL BUG

By Z. P METCALF, *West Raleigh, N. C.*

(Withdrawn for publication elsewhere)

MR. A. F. CONRADI: I would like to ask Mr. Metcalf what he would recommend in practice to avoid the ravages of the corn root worm.

MR. Z. P. METCALF: In North Carolina, as far as my observations and experiments have gone, the dates for planting to avoid infestation of the corn bill bug coincide exactly with the dates for planting to avoid the corn root worm. Very early plantings seem to escape injury and the same is true of very late plantings.

PRESIDENT P. J. PARROTT: We will now have a paper by Mr. A. F. Burgess on "The Present Organization and Methods Used by the Bureau of Entomology on the Gipsy Moth Work."

OUTLINE OF THE WORK ON THE GIPSY MOTH AND BROWN-TAIL MOTH CONDUCTED BY THE BUREAU OF ENTOMOLOGY, U. S. DEPARTMENT OF AGRICULTURE

By A. F. BURGESS

For several years appropriations have been made by Congress for the purpose of preventing the spread of the gipsy moth and the brown-tail moth from the infested region in New England to other parts of the United States. This work is being carried on by the Bureau of Entomology, U. S. Department of Agriculture, and its administration is in charge of the writer under the direction of Dr. L. O. Howard,

Chief of the Bureau. An office is maintained at 43 Tremont Street, Boston, Mass., which furnishes headquarters for the men under whose direction the different lines of work are conducted. A laboratory is maintained at Melrose Highlands, Mass., which serves as headquarters for receiving and disseminating collections of parasites and natural enemies of these insects and for conducting investigations and experiments, the results of which form a basis for work in the field. The entire work is being undertaken along the following lines:

1. Experimental Work.
2. Silvicultural Investigations.
3. Quarantine Work.
4. Scouting Work.

Experimental Work

This work is being carried out under the supervision of the writer and at the present time several distinct projects are being investigated as follows:

(a) Parasite Work.
(b) Field Observation Work.
(c) Food Plant Work.
(d) Dispersion Work.
(e) Disease Work.
(f) Secondary Insect Work.

Parasite Work.—This work is in charge of Mr. J. N. Summers, and has for its object the introduction, breeding, and dispersion of the foreign parasites and predaceous enemies of these insects. It is necessary to make a critical study of the life history and habits of these beneficial species in order that they may be utilized to the best advantage. Much progress has already been made in this direction and several species have already become firmly established in this country, and are doing good work in reducing the increase of the pests concerned. A careful investigation is made each year to determine the increase and spread of the beneficial species and a great amount of valuable scientific data is being secured.

Field Observation Work.—This is being supervised by Mr. C. W. Minott, and has for its object a determination of the natural increase of the gipsy moth under field conditions. Observation points have been selected, aggregating more than 200 in number, scattered throughout the infested region, and care has been taken to secure localities where there are different types of forest growth, different degrees of infestation, and where parasites have been introduced and where they do not exist. A careful study is made during the summer and fall, and accurate records are kept of the increase or decrease of the species in these areas. Also a determination is made of the effect of defolia-

tion on the trees concerned. Areas are now under observation in Maine, New Hampshire, and Massachusetts.

Food Plant Work.—This work is in charge of Mr. F. H. Mosher, and is carried on during the summer at the laboratory in Melrose Highlands, Mass. Caterpillars of the gipsy moth are fed on selected food plants and accurate records are kept of their ability to survive and their preference for the different species of trees which are common in New England. A temporary sub-station for conducting a duplicate set of these experiments has also been maintained and during the past season was in charge of Mr. R. Wooldridge. The information secured by feeding the caterpillars of the gipsy moth in each caterpillar stage is carefully compared each year with the results of the observations made in the field points above mentioned, and information has already been secured which can be used for thinning woodlands so as to leave the trees which are least subject to attack.

Dispersion Work.—This project is being carried on by Mr. C. W. Collins, and consists of an extensive study of the factors responsible for the natural and artificial spread of the gipsy moth. A large amount of data has been secured on the temperature and field conditions most favorable for the spread of this insect, and it has been demonstrated that the newly hatched caterpillars can be carried long distances by the wind.

Disease Work.—Investigations on the wilt disease, which attacks the gipsy moth caterpillars and destroys large numbers of them in bad infestations, are being conducted in coöperation with the Bussey Institution of Harvard University. A large number of experiments are being conducted at that Institution by Mr. R. W. Glaser, who is working under the supervision of Dr. W. M. Wheeler. Check experiments to determine the relation of food plants to the development of the wilt disease were carried on by Mr. J. J. Culver, and an extensive series of field observations was made by Mr. A. W. Young during the summer of 1913 to secure information concerning the relation of temperature and humidity to the development of the disease.

Secondary Insect Work.—In many sections where trees have been defoliated by the gipsy moth they are attacked by the bark borers. Oak trees suffer very seriously in this respect, and an investigation is being carried on in coöperation with Dr. A. D. Hopkins, who has charge of the branch of forest insects of the Bureau of Entomology, to secure more information along this line. Mr. H. A. Preston is working under his direction in making a study of the life history and habits of the principal boring insects concerned, and is carrying on a number of experiments to determine whether this pest can be controlled economically.

Silvicultural Investigations

This work has been taken up in coöperation with the U. S. Forest Service and is being conducted by Mr. G. E. Clement. Its object is to determine the relative resistance to moth attack of different species of timber trees when grown under the best silvicultural condition. The method used in carrying on this work is to select different types of forest growth and put them into the best possible silvicultural condition. These plats are examined from time to time to secure information on the effect of such thinnings and to test the ability of different stands to survive gipsy moth attack. The results of these experiments will give valuable information as to the proper method of managing moth-infested woodlands.

Quarantine Work

The territory infested by the gipsy moth and the brown-tail moth has been placed under quarantine by the Federal Horticultural Board, and regulations have been made providing for inspection of nursery stock and forest products that are shipped from the infested territory to other parts of the United States, in order to prevent the spread of these insects on such shipments. This work is in charge of Mr. D. M. Rogers, and all products of this sort that are shipped outside of the territory are carefully inspected. This protects the country at large and has resulted in preventing the spread of both the gipsy moth and the brown-tail moth to many widely separated sections of the United States.

Scouting Work

This work is being carried on under the direction of Mr. L. H. Worthley, and consists in the examination of the territory around the outside border of infestation. It serves to determine the territory which should be placed under quarantine from year to year. As much work as possible is done to clean up infested places in this outside territory, particularly along the western border, from which section the insect is most likely to spread to other parts of the country. Careful work is being done in several isolated colonies beyond the principal area of infestation, and in some places the insect has been exterminated before there was opportunity for further spread.

Coöperative Work

Field work is being carried on in close coöperation with the work that is done in the infested states, and which is being paid for by state or local appropriations. Arrangements are made so as to prevent a duplication of work and in this way good results have been secured. Coöperation with the states has also been attempted with good results in introducing and checking up the work of the parasites and natural

enemies of both moths, and during the past season arrangements were made at the request of the Entomologist of the Dominion of Canada so that parasitic material was collected in Massachusetts by his assistants and shipped to New Brunswick and Nova Scotia, in order to determine whether the species concerned would be useful in contolling the brown-tail moth which has become established there. Several shipments of parasitic material have also been sent to other parts of the United States, where serious insects occur and where it seemed probable that parasites would be useful in reducing the pests concerned.

MR. HENRY SKINNER: I would like to ask whether any stages of the gipsy moth have been found where it has not become established.

MR. A. F. BURGESS: I do not quite understand the question.

MR. HENRY SKINNER: Some time ago I had a full-grown gipsy moth larva brought to me for identification from Philadelphia, and this is the reason why I asked whether there have been other cases where single caterpillars have been found in territory where the species has not become established.

MR. A. F. BURGESS: I am very sorry that you did not report this case at the time so that we could have had the matter thoroughly investigated. Not long ago specimens of brown-tail moth webs were received from Philadelphia, but on investigation it was found that they came originally from an infested orchard in Maine.

It is possible for gipsy moth caterpillars to be shipped moderate distances and survive, and possibly this is what happened in the case which has been mentioned by Doctor Skinner. As a rule if one caterpillar is found on the property more will be located if a thorough investigation is made. I should be glad to get all information possible concerning this matter so that we can have it thoroughly investigated.

MR. HENRY SKINNER: This occurred several years ago and there is no way by which I can fix the date.

PRESIDENT P. J. PARROTT: We will now take up the next paper by Mr. Wilmon Newell entitled, "A Simple and Economical Method of Filing Entomological Correspondence."

A SIMPLE AND ECONOMICAL METHOD OF FILING ENTOMOLOGICAL CORRESPONDENCE

By WILMON NEWELL, *College Station, Texas*

The handling of correspondence is a necessary part of the work of the economic entomologist and by this means much valuable property is saved from destruction by insects. At the same time, it must be conceded that in offices or departments where the correspondence is

voluminous, it often bids fair to consume the major portion of the entomologist's time. Answering inquiries is legitimate work for the entomologist, but from his standpoint is not "productive labor," for the mere dissemination of entomological knowledge adds nothing new to the science. The entomologist who does nothing more than answer letters and compile popular bulletins does not increase the sum of our available knowledge of insects; research and experiment should constitute by far his most important work. The problem of handling office routine with sufficient speed to leave time for experimental work is constantly faced by nearly all entomologists, particularly by those connected with state institutions, and much of this routine is associated with the answering of the daily letters.

Heretofore but little attention seems to have been given to the methods of filing entomological correspondence, the entomologist using whatever plan or fixtures were available. Several years of experience with various commonly used filing systems convinced the writer that they were not adapted to the requirements of the entomologist.

For example, the vertical letter filing system requires that a folder be numbered and labeled for each correspondent, together with an index card similarly prepared. Both folder and card must be put in their proper places in the files, and the letters themselves must also be numbered and filed. The folders, index cards, transfer cases and filing cabinets for this system require expenditures which often seriously deplete the entomologist's available funds. Aside from the time and expense required to maintain this system, it is not adapted to the purpose, for many correspondents write but once in several years and for them the folders and cards must be indefinitely maintained in the files.

The alphabetical system of filing, wherein the alphabet is divided into many minor sub-divisions, such as "Aa to Ae" and "Aba to Abo," etc., is but little better. While it dispenses with the card index and its attendant work, the system still requires expensive furniture and is a system in which the chances for errors in filing are increased to a maximum because of the similarity of the many sub-divisions of the alphabet.

Four years ago the writer devised a system of letter-filing which appears to combine all the important advantages of other systems but which reduces clerical work to a minimum and the cost to a mere bagatelle. In fact, the cost of materials is less than the cost of the transfer cases for the vertical or alphabetical systems.

The filing is primarily by subject and for containing the letters we use the common pasteboard letter file containing sheets labeled A to Z. Neatly printed labels bearing the following titles are pasted to the backs of the files, one subject or title to each file.

ANTS	STAPLE CROP INSECTS
APICULTURE	ASSOC. OF ECONOMIC ENTOMOLOGISTS
COTTON INSECTS	BILLS & ORDERS
FRUIT & TRUCK INSECTS	CAMPUS
FOREST, SHADE & NUT TREE INSECTS	INFORMATION
FOUL BROOD	GENERAL

These files are kept in any convenient place, preferably on a table, and constitute the "active file," or group, in which the correspondence is filed from day to day (Plate 6). The letters, with the carbon copies of replies attached, are arranged by subject and then filed alphabetically under each subject, according to the name of the correspondent. One has but little difficulty in deciding under what subject any given letter should be filed. Thus, a letter concerning the onion thrips would be filed under "Fruit & Truck Insects," and one about Hessian fly in the file labeled "Staple Crop Insects." Occasionally a letter may be classed under any one of two or more subjects and to cover such cases certain simple rules must be adopted.

The nature of the correspondence falling in the classifications "Ants," "Apiculture," "Cotton Insects," "Fruit & Truck Insects," "Foul Brood," "Forest, Shade & Nut Tree Insects," and "Staple Crop Insects" is at once apparent.

The use of the remaining files is governed by the following general rules:

In the file labeled "Assoc. of Economic Entomologists" is placed correspondence with other members of the Association upon entomological matters of general interest, or regarding Association matters, but not regarding any specific insect problem.

The "Bills & Orders" file covers all correspondence relating to the ordering of supplies and the employment of labor, as well as correspondence relative to the settlement of accounts, payment of bills, etc. It does not, however, include correspondence which is concerned only with the matter of prices or the nature of supplies, apparatus, etc.; this being placed under "Information."

The file "Campus" takes all correspondence with parties located on the College grounds. This is virtually synonymous with such a term as "local correspondence."

Under the head of "Information" we file copies of all letters in which we request information from others, together with the replies to such letters. Under this head come such things as quotations on supplies, identity of specimens sent to other workers, etc. The file does not include anything in the way of information which *we* furnish to others.

The file "General" receives all correspondence which does not fall

within any of the other classifications. Contrary to what one would expect, the number of letters falling in this group is very small and most of them do not relate to entomological matters at all.

At the time the filing boxes are labeled notation of the date is made upon the back of the box. In addition to the subject labels on their backs, the filing boxes are also numbered. These numbers are consecutive for the files of the active group, but are independent of the subjects.

When any filing box becomes filled it is taken bodily from the active group and placed in the "transferred group," notation being made of this date upon the back of the file. Its place is taken in the active group by a new filing box, labeled with the same subject-label and with the number next succeeding the highest number already in use. At the same time the number of the new filing box is placed on the full box just transferred, the figure being written in ink just below the number already on the transferred box. In a similar manner, the number of the transferred box is placed on the new box, but *above* the number already on the latter. In the transferred group (Plate 6) the boxes are arranged according to subject. Thus the correspondence upon each subject is brought together for permanent preservation, and a glance at the numbers upon the back of any filing box shows what box immediately precedes it in the same subject and what one succeeds it. Thus a glance at filing box No. 537, in "Foul Brood," shows that the preceding box in this subject is No. 534 and the succeeding one No. 545. The inclusive dates upon the back of each filing box show the period covered by the correspondence therein.

At the time letters are written, the subject file and number are placed at the top of the letter but for brevity convenient abbreviations are used, such as "C. I." for "Cotton Insects" "F. & T." for "Fruit and Truck Insects," etc.

When filing, the clerk first sorts the correspondence to subject, then files the letters alphabetically in the corresponding pasteboard filing box.

Briefly stated, the advantages of this filing method are:

No index cards to prepare or file.

No folders to label or file.

No wood or metal filing cabinets required.

No transferring except the movement of the filing box from the active to the transferred file and the labeling of a new box to take its place.

Any subject may be discontinued or new subjects added, as may be desired, without interfering in any way with the operation of the system.

Any desired letter can be located as quickly in these files as in the case of any other system, for the correspondence is self-indexing under each subject. The question may arise as to how a letter would be found if one had forgotten the subject. In reply to this we may say that if the entomologist hasn't at least a vague idea of what the letter was about, he has little or no occasion to find it. In actual practice we do not have this difficulty and we also find that when a correspondent refers to some previous letter he invariably gives a clue to its subject-matter.

Perhaps the economy of this system is the strongest argument in its favor. The filing boxes cost us 25 cents each when purchased under the State Stationery Contract, while for $2 we had enough subject labels printed to last about twenty years. As each filing box holds from 330 to 360 letters, it is seen that the total filing cost is about 75 cents per 1,000 letters. Saving the cost of index cards, folders and filing cabinets is not the only economy; much less time is required both for filing and finding letters than in the case of other systems.

This plan of filing would be as ill-adapted to the needs of the business man as his methods are to our line of work and it is the writer's opinion that we should use methods adapted to our needs rather than try to adopt the unsuitable methods of those in other professions. The letter-filing scheme I have attempted to describe is not a "new creation": it has been in use in our office for the past four years, taking care of a correspondence of from 8,000 to 10,000 letters per annum and it has met all requirements.

Question: What do you do when a letter covers two subjects?

Mr. Wilmon Newell: We assign it to the subject which we consider the most important.

Question: Do you put in any references to letters of minor subjects so as to indicate where they are filed?

Mr. Wilmon Newell: We do if we think we will need to refer to these letters.

Question: How many letters do you handle in a year?

Mr. Wilmon Newell: We have been using this method for four years with an average correspondence of from eight to ten thousand letters a year.

President P. J. Parrott: If there is no further business we will now adjourn.

Adjournment.

Report of Section of Apiary Inspection

The conflict of the meeting of this section with a session of the main association resulted in a very small number of inspectors being present. About ten states were represented.

Following the address of President Newell on "The Essentials of a Good Apiary Inspection Law" a general discussion of work as conducted in the different states was given. Most of the inspectors spoke of the necessity of educational work in connection with regular inspection duties. Work of this nature is carried on through articles in the county press, illustrated lectures before bee-keepers associations and farmer institutes and by field talks and demonstrations by inspectors. In most states the appropriations are meager and the majority of the work is being confined to sections where bee-keeping interests are largest.

The great demand for bee-keeping literature was evidenced by the remarkable requests for the bulletins recently issued in New York and Tennessee. These bulletins have been sent all over the world.

General disapprobation of the plan of the meetings which resulted in conflicts was expressed. Doctors Headlee and Britton were appointed as a committee to request the general secretary to arrange for the next meeting of the Section of Apiary Inspection without conflicting with other meetings.

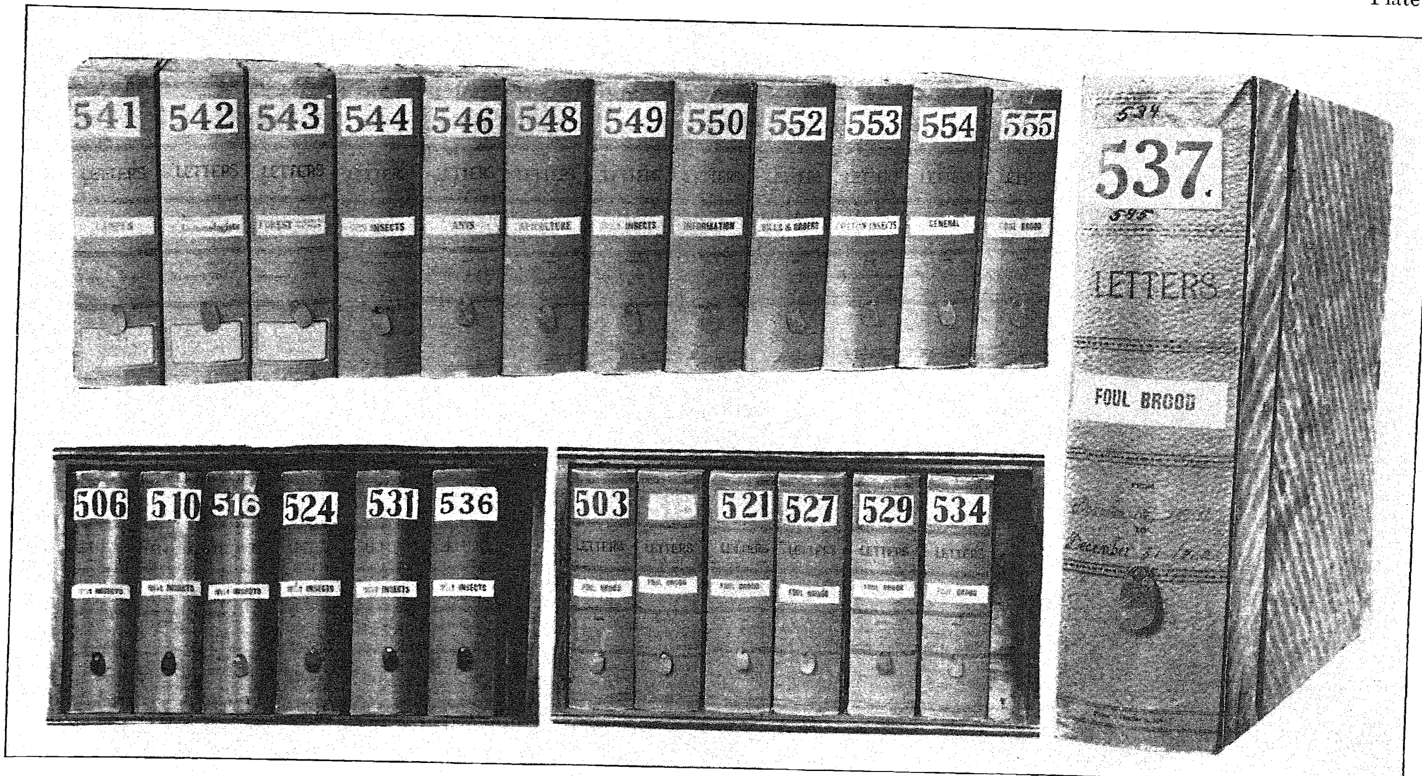
N. E. Shaw of Ohio, was elected Section Secretary.

ADDRESS OF THE CHAIRMAN OF THE SECTION OF APIARY INSPECTION

THE ESSENTIALS OF A GOOD APIARY INSPECTION LAW

By Wilmon Newell, *College Station, Texas*

An efficient law is the first requisite in the eradication of any contagious disease, whether of human beings, farm animals or insects. Perhaps the choice of the term "eradication" is not entirely a proper one. Entomologists have for some time recognized the fact that the eradication of an insect, in the sense of destroying all individuals of the species, is an end rarely if ever accomplished by artificial means. At the same time it must be conceded that contagious diseases of animals have been eradicated, in the fullest sense of the word, particularly within certain defined areas. In like manner we have seen the eradication of American foul brood from individual apiaries and occasionally from areas of considerable size: hence it appears that so far as contagious



Above, "active" file or group; below, portions of the "transferred" group; at right, filing box from transferred group showing manner of numbering.

diseases of bees are concerned, true eradication is not necessarily an impossibility and it is the one thing for which both the beekeepers and inspectors are striving.

The writer would not presume to discuss so weighty a subject as the essentials of a good inspection law, were it not for the fact that he has been directly concerned with the operation of various state laws relative to both nursery and apiary inspection. At this point it may not be amiss to call attention to the fact that many of the principles governing efficient nursery inspection are equally applicable to apiary inspection.

The Texas Legislature has recently passed an apiary inspection law which we believe to be one of the most efficient laws of the kind thus far enacted. This act was not formulated in a hurry, as is often unfortunately the case, but was in course of preparation for four years, during which time it was made to embody not only the features shown by actual inspection work to be necessary, but also the ideas of the best men in the Texas Beekeepers' Association. Several prominent attorneys, themselves beekeepers on an extensive scale, also assisted in drafting the bill. The result was a law which seems to cover the ground thoroughly and to provide for all contingencies which may reasonably be expected to occur. Perhaps one might say then, that the first essential of an apiary inspection act, or bill, should be its careful preparation before it is presented to the law-making body for the latter's endorsement.

As a second essential, we would say that the enforcement of the law should be lodged in the hands of some body as far removed as possible from the influence of politics. In the case of the Texas law active enforcement is in the hands of the state entomologist and this official is directly responsible to the director and governing board of the Agricultural Experiment Station. Local or county inspectors are appointed by the state entomologist, subject to approval of the board. Thus the appointment of the inspectors cannot be influenced in any way by local influences outside the beekeeping industry. While the law does not require such a step, our custom has been to appoint as county inspectors the men endorsed for those positions by the County Beekeepers' Associations, and we have found the plan to work well indeed. Objection is found to placing the execution of such laws in the hands of State Boards of Agriculture or Horticulture for the reason that such boards are usually appointed and their personnel often changes with each new turn of the political wheel. Even where the entomologist or chief inspector operates under the supervision of such a board or commission, he is bound to be influenced to a certain degree by the probable political effect of his operations.

We cannot endorse too strongly the placing of bee disease eradication work in the hands of entomologists rather than beekeepers. While it is true that an intimate knowledge of beekeeping is the first and most important qualification of an efficient inspector, yet beekeeping after all is applied entomology in every sense of the word, and dealing with the diseases of bees is as much entomological work as is the utilization of entomogenous fungi or bacterial diseases in the warfare against injurious insects. The objection to a practical beekeeper having charge of disease eradication lies in the fact that such a man usually lacks the scientific knowledge and training necessary to thorough work.

While the chief inspector, or board having enforcement of the law in charge, must be allowed a certain latitude in the making of regulations, all essentials should be included in the law itself as far as possible. Legislative powers cannot be delegated to boards or officials and, while such authorities may adopt regulations for carrying out the expressed provisions of the law, they can go no further than this without exceeding constitutional limits.

The several states may not pass laws which interfere with interstate commerce and hence state officials cannot prohibit the shipment of nursery stock, or bees, or other commodity into a state. At the same time, it is certain that their jurisdiction over such shipments commences as soon as the latter have crossed the interstate line and the shipments may be stopped, inspected or condemned according to their condition and the state law governing them. The practical effect of this is to prevent shipments into a state except in those cases where the shipments will meet all requirements for intrastate shipment after their arrival. The state law, to be efficient, should provide for adequate inspection and quarantining of shipments immediately upon their arrival within the state and in like manner should provide suitable provisions for preventing the shipping of diseased bees from one point to another within the state. In this connection, the inspector should have full authority to enter depots, warehouses and cars for the purpose of inspecting bees therein which are in transit or which have been accepted for transportation. Provision in the law for preventing the sale or shipment of combs, hives and other fixtures likely to be infected is almost as important as preventing the sale of diseased bees.

One of the difficulties met with in eradication work is the dissemination of the disease through sale or shipment of honey taken from infected colonies. There is little question but what there is widespread dissemination of foul brood by this means and our failure to guard against this constitutes perhaps the weakest point in our present plan of foul brood eradication. At the same time, it does not appear practical to legislate against the sale of such honey and were the states

to legislate against it, there would be innumerable difficulties in the way of enforcing such a provision. However, this does not prevent enactment of a section which will impose a heavy penalty for malicious distribution of diseased honey for the purpose of intentionally spreading disease or introducing it into a new locality.

Among the most important essentials of a good law is the provision which permits of placing quarantines upon specific areas, such as counties or townships. Such quarantines may be either protective or restrictive. By protective is meant a quarantine which protects the quarantined area against the importation of diseased bees or fixtures. A restrictive quarantine, on the other hand, is applied to an infected area and prevents the movement of diseased material out of it. A protective quarantine protects a certain area against disease: a restrictive quarantine protects the state at large against a diseased area. Both kinds of quarantine are absolutely essential to successful eradication.

Another important feature of efficient laws is that which provides for the sheriffs and county attorneys assisting the entomologist or chief inspector whenever called upon to do so. It is also at times a marked advantage for the entomologist to have power to summon witnesses and take testimony under oath. This authority can of course be granted only by legislative act.

The postal regulations at present in effect regarding the sending of queen bees by mail appear to prevent much of the danger of disease being disseminated through this channel and any attempt by the states to regulate the sale or shipment of queens would appear to be unnecessary. At most the state law could include, as one of its sections, the essential requirements of the Post Office Department. Thus there would be no conflict between the two authorities, yet state officials could prosecute violations if it were found desirable to do so. Punishment by the federal authorities would probably be limited to barring the offending queen breeder from use of the mails for shipping his queens.

As it is considered necessary that bees be kept only in frame hives, for the eradication work to be efficient, the problem of compelling owners to transfer their bees from box hives to frame hives is constantly arising. One mistake often made is that of incorporating in the law a section providing for the confiscation of bees which the owner refuses to transfer, or the confiscation of diseased bees. Such a provision is contrary to the constitution of most of the states and if the inspector tried to carry it out literally he would get into no end of difficulties. I am frank to confess that the Texas law I have mentioned contains just such an unconstitutional provision, but in justice it should be said

that its presence in the act was due to the bunglesome error of a clerk, rather than to ignorance on the part of those who drafted the bill or the legislative committees which recommended its passage. Despite the fact that even diseased bees cannot be confiscated without due recompense being made to the owner, the inspector can, under an efficient law, prescribe and enforce such drastic treatment that the owner will destroy the diseased colonies himself rather than stand the expense incident to the treatment. The writer is not in favor of the unnecessary destruction of property; on the contrary, is fully in favor of saving diseased colonies wherever it is possible, but practical experience has shown that drastic action is sometimes necessary. In the case of bees in box hives, also, the inspector can make the transfer himself at the owner's expense if the law so provides. In such cases the cost of having the inspector do the work is much greater than if the owner does it and this is usually sufficient to insure the transfer being promptly made.

There are many other points to which consideration can and should be given in the formulation of an apiary inspection law, but perhaps the ones we have mentioned may possess a suggestive value to those directly interested in securing better legislation in this field.

BEE-KEEPING AND APIARY INSPECTION IN MISSOURI

By Leonard Haseman, *Department of Entomology, University of Missouri*

The annual products of the Missouri bee are estimated to be worth nearly one million dollars, and are the output of about forty thousand apiaries or more than two hundred thousand colonies. This represents a considerable industry, and it is surprising how little actual enthusiasm is found among the bee-keepers of the state and how little state aid is given them in their attempt to improve conditions. In Missouri any attempt to secure state aid must be backed by sufficient evidence that the aid is needed and will produce results if is it given. As yet the bee-keepers have been unable, seemingly, to impress the legislature with their needs. This is not surprising when one considers that the State Bee-Keepers Association, the only association of its nature in the state, has at present a membership of less than one hundred, when there are nearly forty thousand bee-keepers to draw from. This shows a lack of support on the part of bee-keepers themselves, and without that first little state support can be expected.

In 1903 a few of the more progressive Missouri bee-keepers got together and formed the present Missouri Bee-Keepers Association. These few members gradually increased the enrollment of the association to something like one hundred members. It is not a strong

association, though it includes a number of enthusiastic members. At their various annual meetings interesting papers on bee-keeping have been given, and they have helped in many ways to improve conditions of bee-keeping in this state. One of the most important results of their work was the passage of the present Apiary Inspection Law. A number of attempts were made before they finally succeeded in securing the support of the legislature in passing the law. The law is very brief in form, but gives the necessary authority for inspection and cleaning up diseased apiaries. Unfortunately the funds for this work have never been anything like adequate for the ground that needed covering, and consequently the work of the Inspector has been much restricted. From his annual reports it seems a considerable area is covered each year, and a great many diseased colonies are discovered and treated. Considering the area of the state of Missouri and the extent of the bee interests at least five thousand dollars ought to be available for this work, but in no case in the past has there been more than twelve or fifteen hundred dollars available for meeting the expenses of inspection and the salary of the Inspector.

The University and Agricultural Experiment Station have just recently undertaken some special work in bee-keeping. Realizing the necessity of information and assistance along the line of practical bee-keeping, courses are being offered, and investigations are planned for studying the best methods of handling bees in Missouri, and special investigations of more scientific problems which have not yet been fully worked out with bees will be undertaken. The writer has been attempting to expand the work of the entomological department so as to make it cover all lines of entomological work and thereby increase its usefulness. This is one of the more important recent lines taken up, and every effort will be made to improve bee-keeping in this state. There is a growing demand for information and assistance with bee-keeping in this state, and it is a duty of the Experiment Station to encourage and help out with this work.

The Apiary Inspection work is under the supervision of the State Board of Agriculture and it is to be hoped that that Board will give further assistance to the bee-keepers and help to further improve conditions. The Station will coöperate in every way possible with the Board to place Missouri bee-keeping on an equal footing with that industry in other states. The Experiment Station hopes soon to be able to prepare helpful reports on the care of the home apiary and for handling commercial apiaries in this state.

Proceedings of the Twelfth Annual Meeting of the American Association of Official Horticultural Inspectors

The Twelfth Annual Meeting of the American Association of Official Horticultural Inspectors was held in Atlanta, Ga., on January 1, 1914.

The first session was held in the Main Building of the Atlanta Medical College, and was called to order at 2 p. m. by the chairman, E. L. Worsham, with J. G. Sanders, Secretary.

The following inspectors and visitors were present, and especially welcome were the several gentlemen representing the American Association of Nurserymen who are so heartily interested in the movement to secure more uniform state horticultural legislation, and who met with us to discuss the uniform law submitted at the meeting:—

George G. Atwood, Albany, N. Y.; R. Kent Beattie, U. S. D. A., Washington, D. C.; G. M. Bentley, Knoxville, Tenn.; E. W. Berger, Gainesville, Fla.; W. E. Britton, New Haven, Conn.; J. E. Buck, Auburn, Ala.; S. C. Clapp, Raleigh, N. C. R. A. Cooley, Bozeman, Mont.; A. F. Conradi, Clemson College, S. C.; J. H. Dayton, Painesville, O.; Geo. A. Dean, Manhattan, Kans.; Sam H. Dixon, Houston, Texas; H. T. Fernald, Amherst, Mass.; P. A. Glenn, Urbana, Ill.; R. W. Harned, Agricultural College, Miss.; Thomas J. Headlee, New Brunswick, N. J.; Dr. C. Gordon-Hewitt, Ottawa, Canada; W. E. Hinds, Auburn, Ala.; J. R. Horton, New Orleans, La.; S. J. Hunter, Lawrence, Kans.; W. D. Hunter, Washington, D. C.; C. L. Marlatt, Washington, D. C.; Thomas B. Meehan, Philadelphia, Pa.; Haven Metcalf, U. S. D. A., Washington, D. C.; A. W. Morrill, Phoenix, Ariz.; Aven Nelson, Laramie, Wyo.; W. C. O'Kane, Durham, N. H.; W. A. Orton, U. S. D. A., Washington, D. C.; P. J. Parrott, Geneva, N. Y.; L. M. Peairs, Morgantown, W. Va.; William Pitkin, Rochester, N. Y.; Alden A. Potter, Washington, D. C.; Charlotte W. Potter, Washington, D. C.; W. V. Reed, State Capitol, Atlanta, Ga.; W. E. Rumsey, Morgantown, W. Va.; J. G. Sanders, University of Wisconsin, Madison, Wis.; E. R. Sasscer, Washington, D. C.; W. J. Schoene, Blacksburg, Va.; N. E. Shaw, Columbus, Ohio; Franklin Sherman, Jr., Raleigh, N. C.; A. J. Spangler, St. Anthony Park, Minn.; Perley Spaulding, U. S. D. A., Washington, D. C.; W. P. Stark, Stark City, Mo.; H. E. Summers, Ames, Iowa; J. Edward Taylor, Salt Lake City, Utah; E. S. Tucker, Baton Rouge, La.; Ira Williams, Atlanta, Ga.; E. Lee Worsham, Atlanta, Ga.; W. W. Yothers, Orlando, Fla.; Peter Youngers, Geneva, Neb.

The record of the business transacted at the evening session held in the Ansley Hotel is incorporated at this point in the report.

The report of the Committee on Standardization of Phraseology and Value of Inspection Certificates, composed of A. W. Morrill, chairman; Franklin Sherman, Jr., and F. L. Washburn, was presented by the chairman.

It was moved by Mr. Atwood and carried that the report be received and published and the committee be continued. This report will appear later in printed form.

REPORT OF SECRETARY-TREASURER

The affiliation of the American Association of Horticultural Inspectors with the American Association of Economic Entomologists, seems a most commendable departure from our former régime, and should add impetus and power to our efforts in whatever line of work we are engaged. The maintenance of a membership list with annual dues is no longer required since our affiliation.

A balance of $39.27 was received from the former treasurer, and was placed to the credit of our Association in the First National Bank of Madison. Expenditures to date have totaled but $5 for stenographic work, leaving a balance of $34.27.

Respectfully submitted,

J. G. Sanders, *Sec'y-Treas.*

It was moved by Professor Summers and carried by vote that the report of the Secretary-Treasurer be accepted.

By vote of the Association, Prof. J. G. Sanders, of the University of Wisconsin, Madison, was re-elected Secretary.

(Note.—Dr. W. E. Britton was nominated and elected by the Association of Economic Entomologists as chairman of the Section on Horticultural Inspection.)

REPORT OF COMMITTEE ON PUBLICATION, DESCRIBING DANGEROUS INSECTS AND PLANT DISEASES, LIABLE TO BE IMPORTED AND SPREAD ON NURSERY STOCK

At the present time this committee can only report progress. The undersigned were appointed members in March and immediately communicated with Mr. C. L. Marlatt, chairman of the Federal Horticultural Board, requesting that the Board carefully consider the resolution passed at the Cleveland meeting, that a publication be issued giving brief illustrated accounts of "(1) the various dangerous insect, fungous and other enemies of vegetation liable to be introduced on nursery stock or other plant products, (2) similar pests already present in portions of this country and which may be spread on plant products."

Mr. Marlatt replied that "it is expected that a publication of the scope indicated will soon be made available within a reasonable time," by the Bureau of Entomology and further stated that Doctor Howard had already obtained material of the important European pests with this end in view; that further collections would be made; and that in the preparation of the publication the points in our request would be kept in view.

Under date of November 21, a letter was sent to Mr. Marlatt inquiring about the progress of the work of this publication, in view of preparing this report. Mr. Marlatt replied in part as follows:

"I regret that the effort to secure a publication covering important insect pests and plant diseases of foreign countries has not been prosecuted to an advanced stage of completion. Doctor Spaulding, who has been appointed the Pathological Inspector of the Federal Horticultural Board, has, however, in preparation, and is now working on the plant disease half of the project. Doctor Howard has promised to take up the insect half and, through his chiefs of sections, have it perfected. This project will be pushed and, perhaps not this year, but certainly early next year, a publication will be available which will give a brief description and, where possible, illustration of the important foreign insect enemies, the entry of which into this country should be guarded against."

Simultaneously the following letter was received from Doctor Howard on this subject:

"Mr. Marlatt has handed me your letter of November 21, in regard to the matter of a publication giving the important insect pests and plant diseases.

In reply I hasten to inform you, of what you probably know already, that for two or three years past the firm of Deyrolle Fils, of Paris, the well-known dealers in natural history supplies, have, through specially trained men under the coöperative guidance of Dr. Paul Marchal of Paris, been getting together collections of European insect pests in their different stages, paying especial attention to the hibernating stage in which insects are most likely to be carried from one country to another. This collection is designed for purchase by this Bureau, and a large series has already been received here in Washington. These are being put in position for careful illustration, the illustrations eventually to be used in such a publication as that mentioned by you. In the meantime, Prof. A. L. Quaintance's address as retiring President of the Entomological Society of Washington (just issued) deals with this same subject and covers very well the principal injurious insects of the entire world which are liable to be imported. Moreover, a capital hand-book of the insect pests of Europe and a few extra-European countries has just been published as a part of Sorauer's Handbuch für Pflanzenkrankheiten. This has been prepared by Dr. L. Reh of the Hamburg Natural History Museum, and is very well done. It is planned in the Bureau to take Professor Quaintance's address as a basis and to have each of the experts in charge of branches of the work go carefully through the literature and make such additions as they find to the species mentioned by Professor Quaintance; and then it is proposed to publish an advance pamphlet with comparatively few illustrations, which may be superseded at a later date as material for advantageous illustration accumulates."

From the foregoing, it seems that the work on this publication is not only well organized, but is actually well under way, and that we may expect the publication to appear during the coming year. We therefore recommend that this committee be discharged.

W. E. Britton,
T. J. Headlee,
N. E. Shaw,
Chairman.

On motion, the report was accepted and the thanks of the Association extended to the members of the committee.

Afternoon Session

Chairman E. L. Worsham called the Association to order at 2 o'clock and extended the heartiest greetings of the people of Atlanta and of the state of Georgia to the members and visitors, but on account of the length of the program hesitated to address the Association at length.

The following program was presented in order:—

"A Few Problems in Connection with the Administration of the Minnesota Inspection Law," by F. L. Washburn and A. J. Spangler, St. Anthony Park, Minn.

"Notes on Entomological Inspection in the District of Columbia," by E. R. Sasscer, Washington, D. C.

"The Gipsy Moth and Brown-Tail Moth Quarantine in New England," by D. M. Rogers, Boston, Mass. Paper presented by A. F. Burgess.

"The Control of the Boll Weevil by Quarantine,"by W. D. Hunter, Washington, D. C.

"Problems of Plant Quarantine," by W. A. Orton, Washington, D. C.

"Inspection of Plant Diseases," by Perley Spaulding, Washington, D. C.

"The Workings of the Federal Plant Quarantine Act," by C. L. Marlatt, Washington, D. C.

"Uniform State Inspection Laws." Being in part a report of the Committee on Uniform Legislation, by J. G. Sanders, The University of Wisconsin, Madison.

"Nursery and Orchard Inspection Work in Missouri," by Leonard Haseman, Columbia, Mo. (Read by title.)

The following address on "Uniform State Inspection Laws" is in part a report of the Committee on Uniform Legislation appointed at the previous annual meeting at Cleveland, Ohio, and was preliminary to the presentation of a model state horticultural inspection law which will appear later as accepted, in printed form in the JOURNAL OF ECONOMIC ENTOMOLOGY and in some nursery trade publication.

The model law was submitted on December 31, 1913, to a committee of nurserymen gathered in the Piedmont Hotel, Atlanta, Ga., at the invitation of Prof. J. G. Sanders. The following were present during the consideration of the model law:—Messrs. William Pitkin, Rochester, N. Y.; J. H. Dayton, Painesville, O.; Thomas B. Meehan, Philadelphia, Pa.; Peter Youngers, Geneva, Neb.; W. P. Stark, Stark City, Mo.; L. A. Berckmans, Augusta, Ga.; S. J. Hunter, Lawrence, Kans.; C. L. Marlatt, Washington, D. C.; J. G. Sanders, Madison, Wis.

After a consideration of the bill lasting several hours, it was accepted as quite satisfactory with several proposed minor alterations. With these alterations included, the bill was presented to the inspectors at the regular session, and elicited numerous questions, which could not be fully discussed on account of lack of time. It was suggested that members communicate their objections or proposals of changes to the Secretary, J. G. Sanders, at an early date.

The report was accepted and the committee continued.

UNIFORM STATE INSPECTION LAWS

By J. G. Sanders, *The University of Wisconsin, Madison*

The desirability of greater uniformity in the provisions of state laws regulating the inspection and transportation of nursery stock is apparent to everyone who is in any way connected with this important line of work. Much criticism has been engendered by the widely varying horticultural laws and regulations of the several states and districts of the United States on account of the tremendous inconvenience, delay and pecuniary losses.

The national, district and state associations of nurserymen have asserted themselves forcibly in favor of state inspection laws which shall be uniform in every respect possible under the varying conditions and features of the nursery business in the various sections of the United States. This sentiment on the part of the nurserymen is being backed by a considerable fund which is to be used in the furtherance of greater uniformity, and as I understand, their intention is to assist by every honorable means the passage of new laws in some states, and the amendment of laws in others, seeking to introduce in every legislature, wherever possible, such a bill as will be adopted by the nurserymen and inspectors in convention.

This most important problem has been presented in a forcible way to the nurserymen through several channels of publicity, and it is safe to say that practically every nurseryman of importance is familiar with the movement under way.

This Association at its last annual meeting appointed a Committee on Uniform Legislation with Mr. C. L. Marlatt as chairman, Mr. Franklin Sherman, Jr., and the writer as members of that committee to review the various state laws on inspection and to draw up a model bill which should incorporate every feature of the various state laws as far as is possible without distinct conflict. Mr. Marlatt pleaded that he was so completely engrossed by his work as chairman of the Federal Horticultural Board that he preferred to be excused and delegated the entire proposition to the writer. Mr. Sherman pleaded a lack of knowledge of the state regulations, and so many other duties that he would be unable to assist on the committee. Therefore, you will see the two gentlemen who were named as first and second parties on the committee have felt it their privilege on account of rank to delegate this problem to the third member of the committee.

The writer has reviewed the various state horticultural inspection laws and rules and regulations with much interest to find a wonderful conglomeration of ideas, a remarkable mixture of various types of inspection incorporated in one law, and in many laws great verbosity.

The reviewing and digesting of these regulations have been a much greater task than the writer had contemplated. Several of our state laws have combined in the same paragraphs measures for the control and prosecution of several lines of inspection, viz., nursery, orchard, fruit, fruit-package and insecticide inspections, the whole making a mass of regulations from which it is almost impossible to extricate the nursery inspection features.

My first recommendation would be that the nursery inspection be entirely divorced from other phases of inspection, at least that the nursery inspection regulations appear in separate paragraphs from other horticultural legislation.

The second recommendation is that coöperation of national, district and state associations of nurserymen is highly desirable to influence the higher state officials and legislators for a better quality and larger quantity of inspectors who shall be paid salaries sufficient to retain them in the work year after year, so that they could become familiar with every phase of inspection work in their district.

Third.—A similar coöperation is desirable to secure sufficient state appropriation to carry out every phase of the horticultural inspection without handicap, and to remove the necessity as disclosed in some states of demanding a license fee of local and outside state nurserymen, which in many cases is the sole support of the inspection work. Horticultural inspection work of every kind is of state-wide benefit and hence should be supported by state funds rather than by individual assessment.

Fourth.—Some general method of supervision of the inspection work in the various states by the Federal Board with particular reference to a more uniform quality of inspection and to a more uniform certificate seems highly desirable, particularly with reference to nurseries that pack a considerable portion of their stock for interstate shipment. All of us are aware that the quality of inspection varies tremendously in the different states and on that account there has been a feeling of doubt manifested among the states as to the value and intent of an official certificate license.

Practically all of the states west of, and including Montana and Colorado, refuse to accept eastern certificate licenses, and make it a practice to reinspect at point of delivery all incoming plant material. Such reinspection is undoubtedly a wise method under the existing quality of inspection in many states. The nurserymen and inspectors and public in general of the East, where many pests and diseases are prevalent, do not realize the extreme importance and desirability of excluding these pests from the clean Western States by using every available method of inspection and quarantine.

It seems that the time has arrived that nurserymen and inspectors

are being impelled by a more thorough knowledge of the terrible possibilities which would be a resultant of an open door policy or even moderate laxity in horticultural inspection. These two factions, we might call them, are arriving at more friendly terms brought about by a thorough knowledge of the most praiseworthy demands of the other. Each is beginning to realize that their relationship with reference to inspection is to be a continuous performance and with the advent of greater interest and more complete knowledge of nursery pests, the nurserymen are beginning to realize certain problems which the inspectors have been trying to drive home, that no inspection can be too careful, too painstaking or too thorough to accomplish the optimum results.

The inspector is in a peculiar position with respect to the inspection work, a position which is difficult to define, one in which there is no personal gain either immediately or ultimately. It seems that he is acting with a truly scientific and humanitarian spirit in many cases where he is oftentimes working either without salary, or a salary incommensurate with the quality of service performed.

In drawing up the submitted model law, only the most general and necessary regulations have been included which are important features in the work of every state, such as the method of appointment of the inspector and deputies, his duties and powers, definitions of terms used in the law, the treatment of diseased stock on premises, the granting of nursery certificate licenses, misrepresentation of stock, treatment of imported stock, shipping tags, and penalties for violations. An attempt has been made to exclude, as far as possible, all legal verbiage and unnecessary reiteration of terms and phrases, and to use plain English in a manner as concise and definite as seems advisable.

No great claims are made that this submitted law is without fault or possibility of great improvement, but a real attempt has been made to include all of the options which seem desirable in conforming with various state practices and yet arrive at a law which seems to be applicable and available to every state condition in so far as it goes.

The power of making special rules and regulations to satisfy local conditions has been granted the inspector under the jurisdiction of higher authority. An appeal from the orders of the state inspectors appears in section 9, and in sections 23 and 24 mere mention is made of compensations of inspectors and appropriations, fees or other supports of the inspection service; all of which seem to be local matters, yet affecting outside parties to a remarkable degree, especially the matter of license fees, which I trust ultimately will be eliminated from all state laws. I believe that such elimination of fees will be hastened by the coöperation of inspectors and associations of nurserymen with their

united influence and pressure brought to bear upon the proper authorities.

After thorough consideration of the various state laws governing horticultural inspection, several ideas have been conceived which are outlined in the following recommendations to the Federal Horticultural Board and are respectfully submitted for consideration.

Recommendations to the Federal Horticultural Board

1. A national law prohibiting the acceptance by common carrier or any person of any nursery stock for interstate shipment, unless accompanied by a valid state certificate-license tag, certifying official inspection of the contents.

Such a law, in conjunction with the proposed state law, would act as an effective check on unlicensed shipments everywhere in the United States.

2. Several state laws demand that outside state nurserymen file a bond of $500 to $1,000 before selling privileges are granted. Private correspondence with various inspectors, principally Western officials, elicits the opinion that such a demand is justifiable. It may not be unreasonable.

But a more reasonable method of handling this proposition, with less expense, less trouble and annoyance to all concerned, is recommended as follows:—That each nursery desiring to sell, in those states demanding a bond, file a bond of $1,000 with the Federal Horticultural Board which shall make public this fact to the officials of all interested states, and that this bond shall be available for legal action, on demand, or appeal to the Federal Horticultural Board, by any states suffering from violations of its horticultural laws.

3. To eliminate the wholly unnecessary practice of filing a duplicate copy of a state license with the officer of another state to issue a license before carrying on business in that state,—it is recommended (and is provided in the submitted model law, section 6) that each state maintain a complete list of inspected and certificated nurseries and dealers with the Federal Horticultural Board, which list shall be available to the official inspectors of any state.

4. An absolute quarantine may be established by the Federal Horticultural Board, covering any district, state, or group of states, and for any insect, disease, or plant, prohibiting not only shipment *from* an infested or infected area, but also shipment *into* an area known to be clean. The recent California quarantine against shipments of peaches, almonds, nectarines, etc., is typical of action which might be taken for the ultimate good of all concerned. It is further recommended that at the solicitation of state officials thorough investigations be made and appropriate action taken.

5. Certain states demand that all nursery stock from other states shall have been fumigated before acceptance under their laws, and it happens that at least one of those states does not demand fumigation of its own stock for interstate shipment, although San José scale is not a stranger. Manifestly the scale conditions in some of our Eastern States is such that fumigation should be required of all stock for interstate shipment. On the other hand, in Iowa, Nebraska, North and South Dakota, Minnesota, and Wisconsin, where there is little or no San José scale, it would be an unnecessary requirement, and these uninfested states have a right to demand greater protection than they have had in the past.

It therefore seems wise that the Federal Horticultural Board should determine the conditions in our states and use their judgment in establishing a quarantine area from which no nursery stock shall enter interstate commerce, without proper and thorough fumigation with hydrocyanic gas.

The above recommendations are to be considered as personal opinions of the writer, resulting from a considerable acquaintance with nursery pests, nursery conditions and practices, and methods of nursery inspection in several sections of the country.

INSPECTION FOR PLANT DISEASES

By Dr. Perley Spaulding

In your inspection of nursery stock you have already become familiar with the various indications of the work of parasitic insects. It, therefore, will be relatively easy for you to separate the symptoms of diseases caused by adverse physiological conditions and fungous parasites from those troubles brought about by the insects. It may be well to briefly consider the various symptoms of plant diseases. The most common symptoms are the following:

Pallor, either in part or of the entire plant, this usually occurring in herbaceous plants and occasionally in the leaves of shrubs. This is caused by certain adverse conditions of the soil.

Spots on the foliage or occasionally upon the younger twigs of shrubs and upon the main stems of herbaceous plants. These spots may be white, gray, yellow, red, brown, black, or variegated. These are caused by a great number and variety of fungous parasites.

Shot hole of leaves. This usually occurs upon the stone fruits and is caused by the attacks of a fungous parasite killing small circular areas of leaf tissue which fall out and leave round holes.

Wilting, either of entire plants or of parts. This may be caused by

drought, but there are some very serious fungous diseases which have this symptom.

Death of parts of the affected plant, such as the fire blight of pear and apple twigs.

Dwarfing or atrophy of the affected parts of diseased plants.

Hypertrophy or swelling of the affected parts.

Formation of entire new structures, example ergot.

Mummification. This occurs with a considerable number of the fruit rots.

Change of position of affected part. Example, witches brooms produced by certain fungous parasites.

Destruction of the affected organs, example, grain smuts.

Excrescences and malformations, such as galls, cankers, witches brooms, rosette, and punks or fruiting bodies of the large wood-rotting fungi.

Exudations, consisting of pitch, gum, or slime-flux.

Rotting of fruits, leaves, or of stems in woody-stemmed plants.

In the inspection of nursery stock for diseases, we may classify diseases according to the part of the plant upon which they occur into (1) Diseases of foliage, (2) of twigs, branches and stems, and (3) of the roots.

In general, the diseases of foliage are not serious, except upon seedlings or young nursery stock. These diseases are important, however, with the herbaceous plants. The diseases of the twigs, branches and stems are often very serious with the woody-stemmed plants. Examples of such diseases are:

Killing of twigs on roses, etc., by Botrytis.

Killing of stems of conifers and deciduous trees by *Nectria ditissima* and *N. cinnabarina*

The chestnut bark disease, which is the most destructive disease of large trees known at the present time.

The various apple cankers

The rose and raspberry stem cankers.

Killing of twigs of stone fruit trees by the gray rot (Monilia).

The various pine-stem blister rusts.

The well-known black knot of cherries.

Our last group, the diseases of roots, are especially serious, not only because they destroy the feeding organs of the plant, but because they cause more or less serious soil infection, oftentimes lasting for several years or longer. Examples of this class of diseases are the well-known crown gall and hairy root of fruit trees, various kinds of root rots, and, finally, but by no means least, root diseases caused by nematodes or eel worms. The latter are especially serious, because soil once infected

cannot be used for a considerable number of years afterwards for crops of a similar nature. A very serious feature also of nematode soil infection is the fact that some species of nematodes have an immense number of food plants. It should also be mentioned that a very serious disease of citrus trees has recently been discovered to be caused by one of the nematodes. Some root diseases to which attention is now very sharply drawn are the various diseases of the potato tuber, which were so prominent in the recent hearing held in Washington to consider the advisability of total exclusion of foreign-raised tubers.

Finally, I may say a word regarding the diseases which are known to occur in imported nursery stock.

It has only recently been discovered that the chestnut bark disease is a native of China, and was undoubtedly imported into this country.

The white pine blister rust is known to have been imported directly from Europe.

The potato wart and potato powdery scab occur upon imported potatoes.

Crown gall and hairy root have been found upon a considerable number of different fruit trees and also upon several of the ornamental shrubs.

Azaleas have been found quite generally affected with leaf galls caused by an Exobasidium.

Rhododendrons in one case were found infected with a tiny leaf gall caused by a Synchytrium.

Miscellaneous leaf spots have been found upon a number of different species of shrubs.

Clematis has been found affected with root rot.

Pæonia, lilac, and rose leaves and stems have been found with the small black sclerotia of the fungus *Botrytis vulgaris*, which develop in transit.

Finally may be mentioned the finding of the fruit rot fungus *Glomerella rufomaculans*, fruiting on avocado seeds; apparently an entirely new observation for this fungus.

In order that I may be familiar with what you are finding in different parts of the country, I have asked you to forward to me specimens of diseased plants which you may encounter in your inspections. Free and cordial coöperation in this regard will do much to make efficient my own efforts to help you solve some of the knotty problems in connection with inspection for fungous plant diseases.

An exhibit was made of diseased plants illustrating various symptoms of disease.

PLANT QUARANTINE PROBLEMS

W. A. ORTON

MR. CHAIRMAN AND GENTLEMEN: As Mr. Marlatt is to speak to you of the work of the Federal Horticultural Board for the past year, I will not touch on that topic, but will discuss some problems that we have in common for the future, in our great task of preventing the spread of insects and plant diseases, and present some considerations that may govern our viewpoint and policies toward quarantines and inspections.

We have had to deal in the United States with a succession of pests, mostly invaders from foreign lands, and we still find our hands very full with the inspection and police duties necessary for the control of these unwelcome visitors. There is expended in this country a vast sum for this type of work and, as the extermination of the parasites now seems hopeless, we are faced with the necessity of continuing these expenditures until the end of time.

Regret is often expressed that a small fraction of this great sum could not have been available to prevent the introduction of these pests or to exterminate them before they had gained a foothold here. Unquestionably money expended on scientific investigations of means of preventing the introduction and spread of insects and diseases yields much greater proportionate returns than that spent on inspection and control, and had the biologists of a generation ago known what we now know, and had they received a tithe of the support now given by the state, many, perhaps most of these destructive insects and diseases would have been excluded or controlled.

The point I would emphasize today is that we are still far from the end of our journey. By no means all of the dangerous insects and diseases of the world are already with us. There exist in Europe and especially in the Orient, many, many other parasites which would doubtless prove very destructive under our conditions, and danger of introducing them is ever present. Witness the spread of the chestnut bark disease, and the fruit flies we are attempting to turn back from our Pacific and Mexican borders.

To guard against these perils of the future is now our important problem, a problem that has not yet been adequately solved, but which we are infinitely better prepared to cope with than were our predecessors of the last generation, for we have now the legal authority that was formerly lacking, and we have this great organization of state inspectors, backed by the entomologists and plant pathologists of the Experiment Stations and colleges, and supported with relative liberality by a people growing more and more awake to the importance of the work.

We should have ever in mind that quarantines must be based on biological principles established through scientific research, that inspection and regulation are makeshift, although necessary, measures forced upon us by the failure to prevent the original invasion of these pests, and that it is our paramount duty to contribute out of our abundant opportunity to fundamental investigations of means of preventing the introduction and spread of insects and plant diseases. It is my conviction that we are not making the fullest use of existing opportunities. Every state has inspectors whose official travel takes them to every section of their territory, so that as a body they cover the whole of the United States. Can we not enlist the aid of these men in other respects than the examination of nurseries for scheduled parasites? and especially can we not organize a systematic and country-wide survey of the injurious insects and plant diseases of the United States? The beginnings of such a survey have already been made in the Bureaus of Entomology and Plant Industry, but the data available are distressingly incomplete. The purpose of such a survey would be (1) to record the geographic distribution of insects and diseases and their annual prevalence in each section of the country, (2) to estimate the losses suffered each year in order that the economic importance of the subject may be understood, (3) to discover at the earliest moment the introduction into the country of new and possibly dangerous parasites, (4) to study epidemics or unusual outbreaks in relation to weather, crop distribution and other factors, and to obtain a better knowledge of the conditions governing the development, spread, and control of such outbreaks, (5) to gather data respecting the resistance and susceptibility of varieties to disease, for comparison of reports from different sections and correlation with climatological records.

I shall lay special stress on the plant disease survey because the state inspectors are perhaps already duly watchful for insects, but we need your help and that of all your assistants in collecting more data on plant diseases. The Plant Disease Survey, as at present organized, centers in the Bureau of Plant Industry, with the aid of collaborating plant pathologists in each state. The opportunities for travel enjoyed by the nursery inspectors are, as a rule, so much greater that they could be of exceptional assistance in reporting on field conditions if their interest can be enlisted.

I mentioned a moment ago the need of basing our quarantines and other procedures for disease and insect control on scientific investigations. We are embarrassed at every turn by the lack of knowledge on points of vital importance, such as the geographical distribution of a fungus or an insect, its host plants or its full life history. A multitude of details relative to the means of spread of parasites re-

mains to be worked out. The very existence of the parasites of greatest peril has often been discovered after it was too late to prevent their importation, as in the case of the chestnut bark disease. Not only domestic surveys of insect and fungous parasites are necessary, but foreign surveys as well, and there is particular need of information from the lesser known continents of South America and Asia.

That the parasites of other continents are most dangerous is abundantly proved by the experience of Europe with the Phylloxera, the black rot, and the mildew of the vine, and more recently with the gooseberry mildew, and by our experience with the imported gypsy moth, the brown-tail moth, the codling moth, the asparagus rust, the hollyhock rust, and the late blight of potato. Nature tends to preserve an equilibrium between native plants and their parasites, but when this is disturbed by man, through the chance transfer of a parasite, the invader, if a fungus, finds relatives of its original host, which lack resistance to its attacks, or, if an insect, it leaves its own natural parasites behind and spreads in the new field to an extent never known in its native habitat.

These facts greatly complicate our task, for it is hard to foresee where the dangers lie. To secure concerted and coöperative action in all countries would greatly facilitate the work, and it is an encouragement to know that the need for such international efforts is being more strongly felt in Europe, and that a movement which has been gaining headway for many years promises to result finally in definite action in connection with the International Institute of Agriculture at Rome.

THE MOVEMENT FOR INTERNATIONAL PHYTOPATHOLOGY

The term phytopathology in Europe is used to include insects as well as fungous and other troubles, since the field of work of the entomologists there has not been as clearly separated from pathology as in the United States. The history [1] of this international movement dates back at least to 1880, when Dr. Jacob Eriksson, the eminent Swedish botanist, laid a plan for international action before the international congress for agriculture and forestry at Vienna. In 1891, at the International Congress at The Hague, Professor Rostrup called attention to the need of means for preventing the introduction of epidemic diseases through the importation of living plants or seeds infected by parasites. In 1900, Eriksson presented the matter to the Fourth International Congress for Agriculture at Paris, and again in 1903

[1] Louis Dop. Rapport sur la coöperation international dans la lutte contre les maladies des plantes, presenté au congress international de pathologie comparee. Paris, 1912.

to the Seventh International Congress for Agriculture at Rome, where a special committee on phytopathology was formed, composed of representatives from the several countries and headed by Dr. Paul Sorauer, [1] whose Zeitschrift für Pflanzenkrankheiten was made the official organ.

In 1905 the International Institute of Agriculture at Rome was founded through the initiative of the King of Italy. This Institute named as one of its objects the better control of plant diseases, and the subject was discussed more or less at each of its subsequent sessions. In 1907 the Swedish Government presented to the Institute a detailed plan for the creation of international stations for phytopathology, and this was followed by the establishment of a special section for plant diseases.

Dr. Eriksson [2] brought the subject before the Eighth International Congress for Agriculture at Vienna (1907) and in 1908 before the International Botanical Association at Montpellier, where favorable resolutions were adopted. He has also published several independent articles pleading for international action for the control of plant diseases, and in 1905 endeavored to bring about general action in Europe to check the spread of the then recently introduced American gooseberry mildew. The International Association of Academies, meeting in Rome in 1910 discussed the suggestion of Doctors Eriksson and Sorauer and approved the centralization of the work in the International Institute at Rome. This Institute began the collections of data and in 1911 published a monograph on the organization of the service for the control of plant diseases in the countries adhering to the Institute.[3]

In October, 1912, at the International Congress for Comparative Pathology at Paris, the whole subject was fully discussed, and the French Government was invited to take the initiative by calling an International Phytopathological Commission to meet in Rome in April, 1913. This action was taken by the French Government and the date set for April 25, 1913, at Rome, preceding the meeting of the International Institute. Owing to the short notice, however, several governments could not accept and the meeting was postponed. At the

[1] Sorauer, Dr. Paul. Internationaler Phytopathologischer Dienst. Zeitschrift für Pflanzenkrankheiten. Berlin-Schöneberg (1908).

[2] Eriksson, Dr. Jakob. Une lutte internationale contre les maladies des plantes cultivees. Stockholm. 1909. Landtbruksbotanisk Verksamhet vid Kungl. Landtbruks-Akademiens Experimentalfält under Åren 1878–1912. Stockholm. 1913.

[3] L'organization actuelle du service de protection contre les maladies des plantes et les insectes nuisibles dans les diverse pays. Institute International D'Agriculture, Rome, 1911.

meeting of the Institute, May 6–12, 1913, the question was brought up and discussed by a number of the delegates who were plant pathologists. The necessity of such a conference was emphasized and the French Government was asked to repeat its invitation. This has been done and there will be a meeting of the International Commission on Phytopathology on February 24, 1914, in Rome, where it is hoped that the United States may be represented.

The desirability of international coöperation has already been realized in this country. The American Phytopathological Society at its meeting in Cleveland, December 31, 1912, to January 3, 1913, held a symposium on international phytopathology and adopted the following resolutions:

Resolved, That the American Phytopathological Society, appreciating the fact that plant diseases do not heed national limits or geographical boundaries and also the evident limitations imposed upon investigations when restricted by national bounds, respectfully recommend that administrators of research institutions, whether state or national, as well as individual investigators, recognize the importance of establishing closer international relations and take such steps as may be practicable from time to time to this end, including not only more frequent visits of American investigators to foreign countries for field observations as well as research, but also the securing, either by permanent or temporary engagement, of the best of foreign experts in plant pathology.

Though the desirability of international action relative to plant diseases and insect pests is generally admitted, the measures proposed vary exceedingly.

Professor Eriksson has from the beginning argued for one or several special stations for phytopathological investigation, to be supported by the Institute and under its control. He proposes that one of these be devoted to cereal diseases, another to potatoes and sugar beets, and a third to fruits. The stations are to be located where the diseases which are the object of the investigations play an important rôle, and are to continue for at least ten years.

Professor Cuboni has backed the idea of a more efficient inspection of nursery stock, as is indicated by the recommendations which he prepared for adoption by the General Assembly:

[1] The general assembly recommends that the governments adhering to the institute:

(1) Organize, if they have not already done so, a government service of phytopathological inspection and control, especially for nurseries and establishments trading in living plants intended for reproduction.

(2) Enact that all consignments of plants intended for reproduction be accompanied by a certificate similar to that required by the Berne phylloxera convention

[1] International Institute of Agriculture at Rome. Senate Document No. 196, 63rd Congress, 1st Session. p. 31.

to be delivered by the government inspector, certifying that said plant comes from a nursery subject to his control and free from dangerous cryptogamic or entomological disease.

(3) In case one or more states disagree as to whether a given disease should be described as dangerous, or when there is grave reason to suspect the presence of new and dangerous disease liable to be spread by plants not intended for reproduction, the governments concerned should convene a commission of specialists of their respective countries to study and propose the most practical mode of preventing the spread of the disease with the smallest possible loss to the trade of the countries concerned.

(4) The assembly considers that an international agreement is indispensable for the protection of agriculture against plant diseases. Such an agreement should be based on the principles outlined in paragraphs 1 to 3 of these resolutions and should set forth: (a) The measures and methods of inspection and control; (b) a list of diseases recognized as dangerous; (c) what products should be subject to control; (d) the blanks and form of certificate; (e) the mode of arbitration to be resorted to in disputed cases.

(5) The assembly considers that the convening of an international commission of specialists, as proposed by the French Government, would greatly facilitate by its preparatory labors the conclusion of an agreement by plenipotentiaries.

The assembly expresses the wish that said commission convene as soon as possible, and that this may be followed at once by the conclusion of an agreement.

(6) The assembly is of the opinion that whenever the General Assembly of the International Institute of Agriculture convenes, government specialists on plant pathology should meet in a special commission to (a) come to an understanding on common studies bearing on plant diseases; (b) to keep in touch with the results obtained by the enforcement of the international agreement, to communicate these results to one another, and to suggest, if need be, amendments to be introduced therein.

Professor Ritzema-Bos[1] presented the following propositions:

1. That in each country there be established a well-organized phytopathological service through one or more vegetable pathological laboratories, which, by employing special scientists, would be capable of coöperating in international problems.
2. That in each country a sum be set aside annually to defray the expenses of one or more delegates to an international congress of vegetable pathology to be held alternately in the different countries.
3. That the different countries contribute to an international periodical on vegetable pathology, edited by the division of phytopathology of the International Institute of Rome, giving a review of all the important publications on this subject which have appeared in the different countries, also information, furnished by the different countries, on the appearance of important injurious plant and animal diseases.
4. That in the different countries everything possible be done to disseminate among farmers and horticulturists information on the most important injurious plant and animal diseases and means of preventing and combatting them.

Professor Comes thinks it will be difficult to establish international measures which will answer the requirements without seriously hin-

[1] Actes de la quatrieme assemblee generale, Institut International D'Agriculture, Rome, 6–12 Mai. 1913.

dering the commerce of the different countries. Since most of the parasites, animal and vegetable, are more or less scattered in every country, he thinks the work of the International Institute of Agriculture should be along the following lines:

1. To make inquiries to decide what parasites, especially animal, are most dangerous and most likely to be spread, in what definite regions they are found and what regions are free from them.

To publish in the bulletin on Agricultural Information and Plant Diseases the results of these inquiries.

2. When the Institute, through publications, direct correspondence, or by any other means, shall learn of the existence in a certain region of a parasite until then unknown, it shall

a. Verify the information;
b. Determine the extent of the ravages caused by the parasite;
c. Publish the results of these inquiries for the purpose of calling them to the attention of those interested;
d. Finally, that this important object may be properly accomplished, it is necessary that the Bureau of Agricultural Information and Plant Diseases shall be provided with an adequate technical personnel.

Apparently the thought of truly international studies, through the interchange of specialists by the various countries, has not yet been expressed in these European deliberations.

Prof. L. R. Jones,[1] of the University of Wisconsin, has well expressed the American viewpoint:

"There is, however, a broader aspect of international phytopathological problems which has not had adequate general recognition. The recent passage of the Simmons bill shows that, in some degree at least, this is dawning upon our national consciousness. This very bill, however, emphasizes the necessity for studying phytopathological problems in their international relations. Two things are especially needed to this end. First, administrators as well as investigators should recognize the importance of occasional visits by the American investigator to such foreign countries as will enable him to see his problems in their foreign setting. The relation of environment to the predisposition of the host, as well as to the virulence of the parasite, can not be overemphasized and it is often impossible for the investigator of the local problem to realize this except as he may be temporarily translocated.

"Even more should our administrators see from time to time how great may be the gain from temporary or permanent employment of foreign experts. This has been done in the Department of Agriculture

[1] Science, July 4, 1913. pp. 5–6 (A Plea for Closer Interrelations in our Work).

See also Shear, C. L. Some observations on phytopathological problems in Europe and America. Phytopathology, v. 3, pp. 77–87. April, 1913, and

Orton, W. A. International phytopathology and quarantine legislation. Phytopathology, v. 3, pp. 143–151. June, 1913.

often enough and with sufficiently favorable results to justify its further trial. But there are inherent difficulties in the appointment of foreigners to permanent government positions and, moreover, the best of foreigners of mature experience can not be thus transplanted. Neither of these difficulties, however, arises in relation to the temporary employment of foreign experts. It seems to me that the time has come when this should be done with increasing frequency. It would result not only in giving us promptly the best expert advice for immediate application, but, what is scarcely less important, would give the foreign specialist such an understanding of the American problem as would make his further investigations more broadly inclusive of American conditions and insure results proportionately more valuable to us. Every student of the history of plant pathology recognizes the gain to England directly, and to science indirectly, which came from the employment of DeBary by the Royal Agricultural Society as expert upon the problems which arose in connection with the potato disease. Who will measure the advantage to American plant pathology could we have had a professional visit of inspection with obligation for counsel from Aderhold, when he was at the height of his understanding of German orchard pathology; or who will estimate the stimulus to our progress upon cereal rust studies could we have brought Ward to America for even a brief sojourn when he was probing deepest into their fundamentals, providing he came commissioned and committed not alone to see but to advise? Surely if exchange professorships are scientifically and economically justifiable in any field, they are in plant pathology."

THE GIPSY AND BROWN-TAIL MOTH QUARANTINE

By D. M. Rogers, *Boston, Mass.*

A brief statement follows of what is being done by the U. S. Department of Agriculture to prevent the spread, by the inspection of various products, of these two European insects which have become established in parts of New England.

The passage of the Plant Quarantine Act of August 20, 1912, made it possible to put into effect a quarantine of the areas in New England infested with the gipsy moth and the brown-tail moth. This was done by the Federal Horticultural Board and became effective on November 25, 1912.

There had been for nearly two years prior to that date a semblance of such a quarantine by agreement with the transportation companies doing business in the gipsy moth area, and the way partially smoothed

for the more rigid quarantine declared in notices No. 4 and No. 10, which clearly define the areas from which forest products and nursery stock may be shipped only when accompanied by a certificate of inspection, and prohibit the movement of Christmas trees and greenery grown in the territory infested with the gipsy moth to points outside of it.

The area quarantined on account of the gipsy moth includes parts of Maine, New Hampshire, Massachusetts and Rhode Island, about 15,230 square miles. The brown-tail area includes all the gipsy moth territory and about 17,000 square miles additional affecting portions of each of the New England States.

The area quarantined was divided into fifteen sections for forest product inspection, and a competent man assigned to each section. His duties were to visit the agents of all railroad, express and boat companies, and the more important dealers in commodities which require inspection and to instruct them regarding the movement of goods affected by the quarantine, and to inspect such material before shipment.

The railroads issued a circular to their agents, copying the regulations of the quarantine in full, with a small map attached showing the areas affected, and in addition extracts from the nursery laws of several states and Canada.

The entire machinery worked promptly and effectively with almost no friction and general hearty coöperation.

Aside from the fifteen sections in which the agents of the Department were looking after the movement of forest products, a man or a crew of men, as the case demanded, was assigned to the inspection of stock going out from the nurseries within the quarantined area.

Each agent of the Department has a metal badge showing that he is an officer, is provided with blanks for making applications for inspection and certificates to accompany shipments examined. The application and certificate have corresponding serial numbers. The application is returned to the office and filed so that we have a record of the whole transaction. In the case of nursery stock, the tag certificate issued has a serial number, and a sheet, report of inspection, shows the same number and other information which we require. These sheets are returned to the office and a copy is sent to the State Inspector into whose state the goods are to go, so that the stock may be reëxamined at destination, if desired.

A few days less than a year after the quarantine was put into operation, the first report of any moths having escaped the notice of our inspectors was received from New York. Some of Mr. Atwood's eagle-eyed inspectors found a gipsy moth egg-cluster and a brown-

tail web on a carload shipment of cratægus from the Arnold Arboretum, Boston, Mass., to the Park Department of Rochester. The car and contents have been returned to the shippers.

While it is not the wish of the writer to make excuses for any negligence of the Federal force of inspectors, there seems to be a feeling that trees were put into the car which had not been inspected. We shall try not to have it happen again, and want to thank the New York force for finding the insects before they had become established.

The inspection of plants and forest products includes the examination of lumber, cordwood, logs, poles, posts, bark, pulp wood, rough lumber used in crating finished products, barrel hoops, second-hand barrels and boxes, cable reels, and other products which might be chosen by a gipsy moth as a place to deposit her eggs. Many commodities not strictly included in products of the forest are examined. There are a number of quarries in the area from which the shipments of stone for monumental work, building, paving, etc., are made: as these quarries are often located in woodland or have trees near them which are infested, many egg-clusters are deposited on the stones. Our men are constantly scouring their territories in search of similar possibilities.

Occasionally, we get application for inspection of a carload of kindling wood. Any of you can realize that it is a rather long, monotonous task to examine such a shipment, but the men are somewhat consoled in thinking it is not shavings or sawdust. Not long ago eighty hours of work were consumed in looking over, piece by piece, a carload of staves and heads of firkins to be used in packing fish or pickles in Ohio, from which 12 gipsy moth egg-clusters were taken.

Cars in which shipments of lumber or wood have been moved from one point to another within the quarantined area are frequently littered with bark which has been broken off in unloading, and need to be cleaned before reloading with goods destined beyond our lines. The railroad agents in most cases are careful to look after the sweeping, but we have had cases where it has been necessary to have the car unloaded and cleaned before a certificate was issued. In some cases where many carloads of rough lumber or cordwood are to be moved, arrangements have been made with the railroad to use only the same cars to and from the points until the whole lot is transported.

It is now a little more than a year since the quarantine went into effect and there have been issued about 5,000 certificates for forest products, some for a single stick, and a great many for carloads. From these shipments, 2,573 gipsy moth egg-clusters have been removed. During the same time about 7,000 tag certificates have been issued for nursery stock, some for only a handful to go by mail, and many

for carloads, and 237 egg-clusters and 322 brown-tail webs have been taken.

We sent a small crew of men through the market garden districts to inspect boxes, crates, and barrels used by the truck growers in shipping their products. From these 138 egg-clusters were taken.

The areas quarantined at present include nearly all the nurseries in New England. There are a few large ones in Connecticut outside the lines. At the principal nurseries we keep men constantly during the shipping season. The smaller ones, from which only occasion shipments are made, are visited, on request, by the nearest inspector.

When the inspectors are not busy looking over stock going from the packing sheds, their time is spent among the growing stock and enough assistants given them to examine all plants during the autumn. The evergreens are done first for the gipsy moth, and later, as the leaves fall, the deciduous plants are examined for gipsy moth egg-clusters and brown-tail webs. This gives a double inspection and helps a great deal in keeping the moths from breeding on the growing stock. Our records show that 3,280 egg-clusters and 5,749 brown-tail webs were removed during the 1913 examination. During the summer there are enough gipsy moth caterpillars and brown-tail adults blown in to make the inspection necessary each year.

While our system is not entirely perfect, we are covering the territory carefully and inspecting the commodities which are the most exposed to infestation.

A FEW PROBLEMS IN CONNECTION WITH THE ADMINISTRATION OF THE MINNESOTA INSPECTION LAW

By F. L. Washburn and A. J. Spangler, *Nursery and Orchard Inspection Service*

During the winter of 1912–13, the Minnesota State legislature passed a bill relative to the inspection of Minnesota nurseries and foreign stock which, in most of its provisions, fulfills the requirements and is working satisfactorily. The inspection is compulsory upon all nurserymen and all imported stock; that is, stock grown outside the United States or Canada. The entomologist is further empowered to enter any premises, whatever, if he deems it necessary and order infested material, whether shade trees, orchard trees, shrubs, or plants, treated, or, if treatment is not practicable, is authorized to order the owner to destroy such plants or trees. This power should be, and will, we believe, prove, a potent factor in the control of shade tree pests upon private grounds whose owners are indifferent,—a most important problem in Minnesota at present. Our appropriation is rather small,—only $3,000 per annum for the next biennium,—with the privilege of drawing upon the State

Entomologists' Fund, if necessary. Consequently, if we had to proceed against many individuals, unwilling to comply with the law, we would, in view of the fact that the infestation of Minnesota oaks is very widespread, be seriously embarrassed for want of funds.

More important in this discussion than the fact of lack of funds, a fault which we hope will be remedied at the next session of the legislature, are certain points in connection with the law which, at the present time, are subject to criticism, even on the part of those who are responsible for the wording of the law and the carrying out of the provisions therein. These problems we lay before you, hoping to receive from you helpful suggestions and perhaps being, in a small way, responsible for at least a few ideas welcome to inspectors at this meeting. Some of our problems many of you have doubtless solved, and you may smile at the fact that they present difficulties to the Minnesota officials; nevertheless, please regard us as suppliants before you, asking for suggestions born of your experience and we hope you will respond generously to our request.

The first criticism that we have to make upon our new law, as well as upon the wording of the law in some of the other states, is that the term "nursery" in not defined, leading to embarrassing inquiries, at times, as to whether we are dealing with a nurseryman or a dealer,—the latter not being entitled to a regular certificate such as we grant nurserymen. We have been obliged to meet more or less criticism this year from men whom we designate as dealers and who, in consequence, by the wording of our law, are necessarily restricted in the scope of their business. Manifestly, a man who can show the inspector one quarter of an acre of land which, indeed, he may rent and not own and on which he has planted left-over stock, is not a nurseryman, but a dealer; but let him stick into the ground a dozen or fifty willow cuttings and, technically, he has a nursery for he is "propagating stock for sale" and on a legal technicality, is entitled to a regular nurseryman's certificate. To grant such a certificate, under these conditions, would be manifestly absurd and to guard against such a contingency and, at the same time, be generous in our attitude, we have decided to give a nurseryman's certificate to any seller of nursery stock who can prove to us that he propagates upon his premises, owned or rented, at least 50 per cent of the stock which he sells. If he buys more than 50 per cent he is entitled only to a dealer's certificate. This decision was arrived at after first consulting our attorney-general who declared, in the absence of any definition in our law, that it is evidently within the province of the state entomologist to determine what is a nursery and what is not, and after interviews with many of our leading and well-established nurserymen recognized as responsible business men,

all of whom concurred in the statement that they only imported from 5 to 10 per cent of the stock sold, such per cent, occasionally, in exceptional years, running a little higher, possibly amounting to 15 per cent, rarely to 20 per cent. All of these nurserymen agreed that if any citizen selling nursery stock could prove that he raised half of what he sold, he should be entitled to a regular certificate and not merely be regarded as a dealer. This problem, therefore, is virtually solved. It must be borne in mind, however, that a few cuttings thrust into the ground by a dealer, might, in view of a decision of one of our Supreme Courts, transform a dealer into a regular nurseryman and be the cause of reversing any decision that the state inspector had made to the contrary.

Another problem, and one which constitutes a serious criticism upon our law is found in section 7, which provides for a special certificate for dealers and florists but obliges them to purchase all their stock from Minnesota nurseries or to sell under said certificate foreign stock (that is, European), inspected in Minnesota. That this section is not carefully framed must be evident to every one of you. Worded, primarily, to meet the needs of firms who bought stock of Minnesota nurseries for immediate selling, or imported stock for that purpose from Europe, with perhaps the additional view of preventing unscrupulous dealers from buying non-hardy stock from any source whatever, it nevertheless works a hardship upon honest dealers,—and there are many such—by obliging them to buy all their American grown stock in Minnesota. This is manifestly an injustice and we shall seek to have a change in this section at our next legislature.

Whether or not the inspector should feel privileged or is justified in interpreting the wording of the law in such a way as not to allow it to work a real hardship in individual cases is perhaps another problem. As one of a number of examples which might be cited, section 6 of our law declares it to be unlawful for any party to open a package containing foreign stock unless the inspector or deputy is present and since shipments from abroad frequently arrive in such large numbers at one time that our force cannot immediately comply with all the calls sent in, these consignments would suffer if the consignees were compelled to leave them boxed waiting for our coming. In extreme cases, therefore, we have allowed them to unpack this stock while waiting for our inspectors.

We have been somewhat embarrassed by the fact that small consignments of European stock, not inspected in the state to which they are originally consigned from New York, have been forwarded to individuals in Minnesota, obliging us to take several long and comparatively expensive trips to inspect, possibly, one box of stock in each town. For example, a large consignment shipped to brokers at Mil-

waukee was reshipped by this firm to separate individuals in Minnesota, namely, parties at Red Wing, Lake City, Austin, Waseca, Virginia, Winona, and Mankato, embarrassing us as before outlined. Is it not possible to avoid this by having such stock inspected at port of entry,—in this individual case,—in Milwaukee? If this is not possible, we could still be relieved of much travel and expense if it were regarded safe to exempt from inspection azaleas and possibly hydrangeas also, since many of these shipments consist of these shrubs.

In the same line, we might mention the fact that we do not pretend to go to the expense of time and travel necessary to inspect shipments received from quarantined areas in the Eastern States, notice of all of which we receive in the shape of yellow slips signed by D. M. Rogers. In view of the fact that these consignments have been inspected by both federal and state officers, we feel relieved of the responsibility of examining them upon their arrival in Minnesota. We would be glad to hear of the practice of other inspectors in this connection.

The Minnesota law requires the filing with the state entomologist of "a copy" (it should be "a duplicate") of the certificate of any firm outside the state shipping nursery stock into Minnesota to be sold or distributed. We hardly see how it is possible to enforce this. In other words, how can we make sure that we receive all of these copies required by the law? We would like to hear the expressions of others upon this point.

Other minor problems which have caused us more or less serious consideration are the following:—Is it feasible to encourage the passage upon the part of legislatures of an act imposing a penalty for knowingly having any imported or native insect pests (naming certain particularly destructive insects) upon one's premises? Michigan, we believe, has such a law and we should be glad to learn how it has worked.

Again, is there any objection born of the experience of any of the inspectors, to permitting nurserymen, in printing copies of certificates to leave out the dates and certificate numbers and fill in these blanks later with pen, in order to allow them to print a large number of tags at once and avoid the loss of left-over tags at the end of the year? The larger nurseries are not concerned over this and the above requests have been made of us only on the part of some of the nurserymen whose shipments are quite limited. Some of these,—a few—are known to do this and, so far, we have not offered objections. A suggestion which comes from one of our nurserymen is to the effect that the State Inspection Service might furnish small electrotypes (costing about 15c each) about $1\frac{1}{2}$ x 2 inches, to the nurserymen, one to each, with the words "Inspected. Minnesota, F. L. Washburn, 1913,"—the original copy of certificate being in each case on file with the nurseryman. His

suggestion was based upon the fact that to print the entire certificate on a small tag to accompany a small parcel-post shipment is embarrassing, occupying as it does, so much room; and a needless expense—calling for a tag sometimes really larger than the package itself. He would much prefer a small tag with firm name, caution as regards frost and heat, and the above stamp, leaving plenty of room thereby for postage. This would be a convenience and a saving and might be done upon intrastate shipments in Minnesota, for the law (another point to be criticized) reads "accompanied by a certificate of inspection" and not "copy of certificate"; but we have pointed out to this party that the wording of the laws of most of the other states and the wording of the federal law is such as to require an actual copy of certificate granted.

A prominent firm in Minneapolis has recently received, from a New York firm, a consignment of 2,000 roses largely or entirely infested with crown gall, reported by our Plant Pathology Division as identical with crown gall of the apple. This package was accompanied by a copy of a New York certificate.

We pointed out to a representative of the firm receiving the roses the dangers of using these plants and he, of his own initiative, refused to accept them, and the firm referred to has had them returned, writing us an indignant letter to the effect that they had never known crown gall to infest roses; that the theory of its being contagious was still in doubt, that these roses did not come from their own grounds and hence they had not seen them, and stating finally that, since these plants were to be potted and used for forcing and then thrown away and not planted in other grounds, there could not, by any possibility, be a chance of sound rose plants being infested.

In writing them I deemed it necessary to contradict several of their statements particularly the last, for it is quite a common practice to plant these forced rose bushes outside, in the spring, where they thrive, blossoming every year. Had the consignees not refused to take them, or had the New York firm left them in Minnesota, we should have destroyed the consignment. Now, some state may receive this same lot. Is there any inspector here willing to permit them to remain in his territory? This really presents no *problem*, yet I mention it here desiring to know what action would have been taken by other inspectors under similar circumstances.

NURSERY AND ORCHARD INSPECTION WORK IN MISSOURI

By Leonard Haseman, *Columbia, Mo.*

For a number of years fruit growers and nurserymen in Missouri have attempted to decide on an adequate inspection law, but for various reasons, the most important of which was lack of enthusiasm and overabundance of friction, nothing of importance was done. In 1899 and again in 1901 inadequate bills were passed by the legislature, and in 1908 and 1910 unsuccessful attempts were made to pass a better law.

With the passage of the Federal Quarantine Act, and the more strict enforcement of state laws it was finally absolutely necessary that something be done to provide for adequate nursery inspection work. Other states began to refuse to accept Missouri inspection certificates since there was no state law which could compel unscrupulous nurserymen to honor the certificates which they received from the inspector. There was also no provision for regulating the introduction of stock into the state or for inspecting such shipments as might need it. In fact, Missouri was for years a national dumping ground for nursery stock which could not be disposed of elsewhere. This unloading of undesirable nursery stock has gone on for years, and it, together with the distribution of similar home-grown stock by a few of our unscrupulous nurserymen, has provided the state with a goodly supply of all nursery and orchard insects and diseases capable of maintaining themselves in this climate, which includes about all of the horticultural pests found in this country. Missouri is fortunate, however, in having so many progressive nurserymen who are awake to the necessity of having effective inspection, and they are very largely responsible for the passage of the present state inspection law.

During the fall and winter of 1912 the writer devoted considerable time to a study of the nursery inspection laws and systems in the various states where this work is properly handled, with a view of preparing a law which would be as nearly uniform as possible with the present laws of other states. The first complete draft of the law was submitted to the nurserymen of the state, during the annual meeting of the Western Association of Nurserymen, for their consideration. A number of outside nurserymen were also called on for suggestions. The only objection of any importance was as to the manner of the administration of the law. The State Agricultural Experiment Station was placed in charge of the work and at first there was some objection to this, but in time the nurserymen as a body united with the State Board of Horticulture representing the horticultural interests of the state and secured the passage of the bill.

The Missouri law was framed to meet Missouri conditions first of all, and it does this very well we believe. It was made as broad as possible so as to take care of future conditions not now foreseen, and still it is sufficiently explicit to properly cover present conditions. It has a few provisions not found in all state inspection laws, and some have been omitted, whose only value is to attract attention and create undesirable objection. It was framed to accomplish results with as little friction as possible. A brief survey of some of its more desirable features may be of interest to those in charge of the inspection work in other states, and especially to those interested in the revision of old or the passage of new inspection laws.

The law provides, first of all, for two distinct and definite lines of work—police duty and education. It provides properly for the enforcement of the police work and when necessary that power will be exercised, but we believe that much of that more or less disagreeable work can be more successfully carried out by the proper administration of the educational phase of the work. We hope to accomplish more through education than through the courts of law. It was this opportunity for carrying out a state-wide campaign of education that induced the Agricultural Experiment Station to take charge of the work.

Along the line of police duty, provisions are made for the regular annual inspection of nurseries, the condemnation of diseased or infested stock, the collection of the actual necessary expenses of inspection and a $5 certificate fee from each nurseryman and the issuing of a certificate of inspection for stock which passes inspection. Provisions are also made for the inspection of any and all orchards or other grounds suspected of harboring dangerous insects and diseases, and the condemnation, treatment and, if necessary, confiscation of such infested or diseased stock or material. It also regulates the introduction of nursery stock by requiring all outside nurseries to secure a state permit which is issued free of charge upon receipt of the necessary papers. It also requires all salesmen or agents to secure an agent's permit to to operate in the state. The law further provides for regulating the dealer or jobber business. In the past the dealer or jobber has done more to run down horticulture in the Middle West than any other one thing. The nurserymen seem unable or unwilling to regulate him, so our law has attempted it in this state. The dealer is required to file under oath a statement of the source of all his stock and file certificates covering same, and on payment of the $5 certificate fee receives a dealer's certificate which is good for all shipments inside the state. With the earnest coöperation of all nurserymen we hope to be able to handle this oft undesired branch of nursery business in Missouri. Not all state laws attempt to reach the jobber as was shown in a recent case

where we were obliged to issue to a dealer in a neighboring state, one of our dealers' certificates to enable him to operate in Missouri. In short the law is framed so as to enable us to reduce to a minimum the chances of further introductions of pests and diseases, and the further distribution through local agencies.

The provisions for educational work require that the Agricultural Experiment Station provide demonstration work in orchard management and the protection of other property from dangerous pests and diseases. It is also required to investigate and report on such pests and diseases and to furnish lectures and printed literature on such subjects. Every effort is being made to make this one of the most important of the recent Experiment Station projects. Already the demands for demonstration work and other assistance and coöperation are pouring into this office, and they will be handled just as rapidly as possible. A keen interest is being shown in this work both byfarmers and nurserymen. The station hasn't always had the coöperation of the horticultural element of the state, but this new law is sending them to us, and we believe Missouri horticulture is entering upon a new era, and that with sufficient men and means we can change Missouri from a state which has cut down more fruit trees than most states have yet planted, to the state producing the best and cheapest of orchard fruits.

One feature of the law deserving of special notice is the provision for its administration. This important work is too often placed under the control of private or political interests, and every attempt was made to prevent such an occurrence in Missouri. We also felt that for a law of this nature to carry the most weight possible it should not be controlled or unduly hampered by the nursery interest which it is meant to regulate, and at the same time to protect. Drug inspection controlled by druggists and the inspectors even appointed by them would be a mere letter head without any weight. The one institution in the state which is able to administer such a line of work without private or political influences is the Agricultural Experiment Station, and from the nature of the work and the equipment of the station it is the one logical institution to handle this particular work. The station has the men, it has the necessary equipment, responsibility, and, in our case, it is actually furnishing much of the funds needed for the first biennium. The biggest step toward uniform inspection would be to make of it in each state a regular Experiment Station project as Missouri has done. This would obviate many difficulties.

During the summer more than 125 nurseries comprising nearly 3,000 acres have been inspected. Twenty-five of the smaller and previously uninspected of these were found needing special treatment before an

inspection certificate could be issued. Most of these had or were near infestations of San José scale. To date 111 inspection certificates have been issued, 57 dealers' certificates, 96 permits to outside nurserymen and 294 agents' permits. This has kept the writer, with one assistant and one deputy, during the summer season, busy, considering the fact that we have also the college and station work to administer. We have also been busy with the shipments of foreign stock, and have begun the first of our winter demonstrations for the control of San José scale.

We feel that we have already made a slight beginning and with the continued earnest coöperation of fruit growers, nurserymen and colleagues we hope to be able to protect all home interests affected by the law, and to be of some assistance in the protecting of similar interests in other states.

PLANT-LOUSE NOTES FROM CALIFORNIA

By W. M. Davidson, *U. S. Bureau of Entomology, Walnut Creek, Cal.*[1]

Pemphigus californicus Davidson. Close observations on the habits of this species indicate that it migrates towards the end of April from the buttercup to the ash (*Fraxinus oregona* Nutt.). The third generation on the buttercup all become winged lice and forsake the plant in a body. They and their immediate progeny cause the leaves of the ash to curl in a manner similar to that caused by *Pemphigus fraxini-dipetalæ* Essig. In May, the shrivelled migrants may be found in the curled leaves together with the apterous lice of the second and third generations on the ash. These apterous lice have undeveloped eyes, the first generation of them being large bloated individuals. The third, or second apterous, generation on the ash is composed of both winged and wingless individuals.

Lachnus thujafalinus Del Guercio. Infests branches and twigs of cultivated Thujas. In California winged lice appear in April. Collected at Palo Alto and Walnut Creek, California.

Lachnus ponderosæ Williams. Observed in abundance in August, 1912, at Glenbrook, Nev., and Tallac, Cal. (elevation 6000 ft.) on twigs and branches of *Pinus ponderosa* var. *jeffreyi* Vasey.

Phyllaphis ? querci Fitch. Mr. J. J. Davis has kindly identified this louse described and figured by him in the Entomological News, Vol. xxii, June, 1911. I have taken it in the fall on the under side of leaves of *Quercus agrifolia* Nee, the sexed forms appearing in early November. Towards the end of April, the stem mothers appear on the upper side

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[1] Published with the permission of the Chief of the Bureau of Entomology.

of the leaves of *Q. agrifolia* and *Q. lobata* Nee, tightly curling over the edges of the leaf and thus forming a pseudo-gall. The second generation are wingless and remain in the gall until mature, when they leave the gall for the under side of adjoining leaves, living thenceforth unprotected except for the wooly covering characteristic of the species. I have observed this aphid in Placer, Contra Costa and Santa Clara Counties in California. In Placer Co. it infests the Interior Live Oak (*Q. wislizenii* A. DC.).

Chaitophorus sp.

Stem mother: Pale yellowish-green with two longitudinal light green stripes on the dorsum of thorax and abdomen. Antennæ six-jointed (filament regarded as a joint), one-quarter as long as the body, pale, first two joints slightly dusky. Eyes small and undeveloped. Legs pale, tarsi dusky. Cornicles appearing as dusky-rimmed pores on the surface of the body. Cauda globular, pale. Whole body except the head clothed with short, stout, erect white spines. Measurements: Body, length to tip of cauda, 2.00mm.; body, width (maximum), 1.16mm.; cauda, length, .054mm.; antennæ, joint III, .207mm.; joint IV, .100mm.; joint V, .100mm.; filament, .024mm.

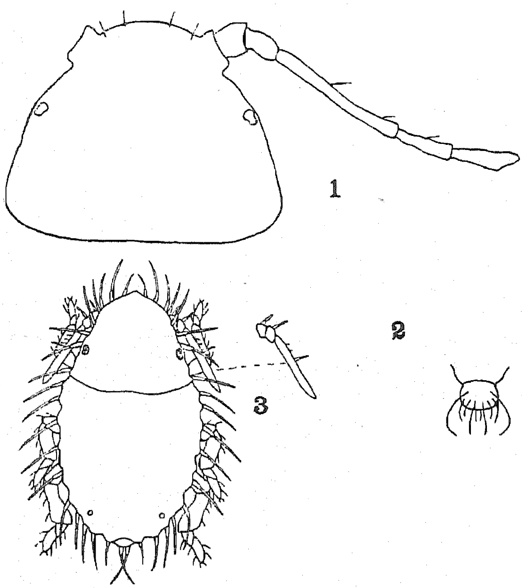

Fig. 1, *Chaitophorus* 1, stem mother, head; 2, stem mother, cauda; 3, dimorph.

Dimorph: Entirely pale yellowish-white, flabellæ hyaline. Body short, oval, very flat. Eyes black, not well developed. Antennæ three-jointed, distal joint three or four times as long as the two basal combined; articulations rather obscure. Legs stout, bearing hairs. Beak pale, barely reaching second coxæ. Flabellæ, long, two-jointed, sharply pointed at apex, narrow, the basal joint the broader; longest pair, .08mm.; basal joint about one-third as long as distal joint; latter easily broken off leaving basal joint with sharply pointed apex. Each antennal joint bears a flabella shorter than those of the body. Flabellæ spaced almost regularly around the margin of the body, 38 in number. Cornicles short, pale, erect from the body. Cauda short and blunt.

Provisionally placed in *Chaitophorus*.

The stem mothers were observed April 13, 1913 on the leaves and stalks of *Quercus lobata* Nee. On that date they were surrounded by young of the second generation. Ten days later before any of these young had matured an invasion of Lampyrid beetles apparently

annihilated the colony of lice, but on May 30, a few dimorphs appeared. These probably belonged to the third generation. Habitat; Walnut Creek, Cal.

Euceraphis betulæ Kalt.

Stem mother: General color apple green. Body clothed with short bluish-white pulverulence (much less than in the winged female of later generations). Head olive green with a central black longitudinal stripe. Prothorax, thoracic lobes and scutellum, olive green. Eyes dark red. Antennæ on frontal tubercles, a little longer than the body, black (joint I, green); basal third of joint III, thickened to include about 16 transversely-oval sensoria; joints IV and V with the usual apical sensoria. Wings large and narrow; stigma long, very pale yellow; sub-costa dark brown; stigmatic vein entire and deeply curved. Legs yellowish-green; tarsi, apical third of tibiæ, apical third of middle and hind femora, brownish-black. Abdomen with almost parallel sides, not wider than the thorax; color apple green with three dusky cross-bands on the dorsum. Cornicles pale yellow, almost twice as long as broad at the base, slightly constricted in the middle. Cauda globular, concolorous with the body, slightly longer than the cornicles. Beak reaches midway between first and second coxæ, pale. Sterna brown. Measurements: Body, length, 3.20mm.; body, maximum width, 1.11mm.; wing expanse, 9.37mm.; cornicles, .128mm.; cauda, .150mm.; antennæ, joint I, .157mm.; joint II, .085mm.; joint III, 1.50mm.; joint IV, .814mm.; joint V, .588mm.; joint VI, .205mm.; filament, .129mm.; Hind tibiæ, 2.17mm.

The newly-hatched stem mothers are brownish-yellow with pale yellow appendages, thus differing from those of later generations which are bright green. The pupæ of stem mothers are reddish-yellow with dusky cornicles and four longitudinal rows of dusky spots on the dorsum.

Young stem mothers were observed to hatch from winter eggs as early as the middle of February, while the leaf buds did not open until March 1, the lice feeding entirely on the stalks. In California this species occurs on cultivated birches.

Eucallipterus arundicolens Clarke.

Winged viviparous female: Pale yellow; head pinkish; eyes dark red. Head with a median dorsal brown stripe. Prothorax pale with median brown stripe, and with two lateral longitudinal brown stripes on its anterior half. Each lateral thoracic lobe with a median brown stripe. Scutellum pale with the outer ends brown. Abdomen narrow, oval, pale yellow with a pair of dark brown tubercles on segments 2 to 8 inclusive; 9th segment with a brown median spot or stripe. Cornicles as broad as long, dark brown. Cauda pale, globular, about as long as the cornicles. Appendages; antennæ about as long as the body, on frontal tubercles, pale yellow; joint I, reddish; joint II and basal half of III, dusky; apices of remaining joints and whole of filament dusky; joint III is longest; joint VI is longer than the filament; joint V is longer than VI and its filament combined; five to eight transversely-oval sensoria occur on basal third of joint III and the usual terminal are to be found on joints V and VI. Wings considerably exceeding the body in length; stigma, pale greenish-yellow, long, narrow; stigmal vein, absent in the middle; veins, brown; second fork of third discoidal nearer to first fork than to wing apex. Legs, pale yellow throughout. Beak, reddish, reaching to first coxæ. Head on under side, reddish. Sterna yellow. Anal plate deeply lobed. The antennæ alone have a white powdery covering. Meas-

urements: Body, length, 1.97mm; body, width, .604mm; wing expanse, 5.6mm.; cornicles, .067mm.; cauda, .064mm.; antennæ, joint I, .088mm.; joint II, .086mm.; joint III, .80mm.; joint IV, .572mm.; joint V, .474mm.; joint VI, .247mm.; filament, .185mm.

Pupa: Wholly yellow with dark red eyes, and apices of antennal joints III to V brown; head with a faint reddish tinge. Antennæ longer than the body. Body spinous.

This species is to be found on the under side of leaves of Bamboos (*Arundo* spp.). I have never been able to collect the sexed insects.

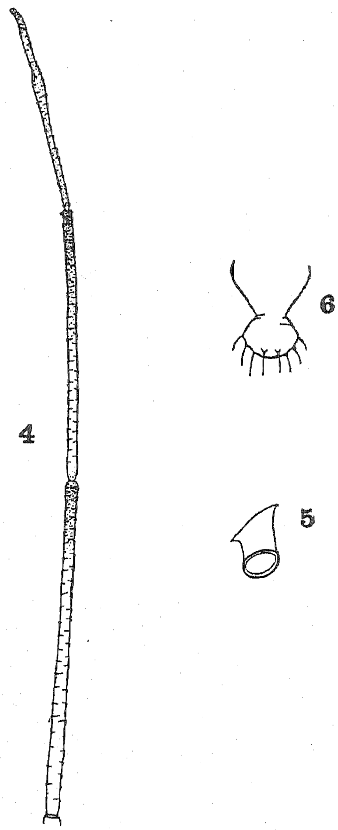

Fig. 2, *Eucallipterus arundicolens;* 4, winged viviparous female, antenna; 5, cornicle; 6, cauda.

Myzocallis quercus Kalt. (?)

Winged viviparous female: General color, pale pea green; antennæ as long as the body, pale greenish-yellow, apices of joints III to VI and whole of joints I and the filament, black; joint III, longer than IV and V together. Thorax of slightly darker green than the abdomen. Wings long and ample; veins slender, brown; stigma, with a faint brownish cloud and with a basal black spot; stigmatic vein entire; apical cell of the wing rather small. Legs, yellow or yellow-brown; tarsi, dusky brown. Abdomen with three pairs of short dusky tubercles on the dorsum of segments one to three inclusive; the pair on segment three about twice as long as those on segments one and two. Cornicles black, in some individuals the base is pale; as wide at the base as long, slightly tapering toward apex. Cauda, concolorous with the body; globular, not as long as the hind tarsus, but about equal in length to the cornicles. Beak, pale, tip black, extending not quite midway between first and second coxæ. Sterna, pale green. Sensoria as follows: III, 7; IV, 0; V, usual apical; VI, usual apical. Measurements: Body, length, 1.78mm.; body, width, .69mm.; cornicles, .052mm.; cauda, .055mm.; antennæ, joint III, .570mm.; joint IV, .286mm; joint V, .250mm; joint VI, .117mm.; filament, .076mm.

Described from specimens collected October 25, 1912. Oakland Cal., on *Q. robur* L.

Pupa of winged viviparous female: Pale green, wing-pads, white; dorsal tubercles absent; abdomen, armed with slender capitate spines; cornicles, slightly dusky.

Oviparous female: Pale lemon yellow; posterior half of the body with a pinkish or orange-colored tinge; eyes, red; antennæ half as long as the body, pale; distal half of joints IV to VI and apex of joint III, black; filament, dusky; tarsi brown; hind tibiæ, somewhat swollen; caudal segments of the abdomen drawn out into a conical tube; cornicles, concolorous with the body or somewhat dusky, varying in degree

of duskiness, as wide at the base as long; cauda, pale, globular, as long as cornicles; cephalic margin of head with four capitate hairs; margin of abdomen with a few short capitate spines; beak, pale, tip brown, extending beyond hind margin of prosternum. Measurements: Body, length, 2.45mm.; body, width, 1.12mm.; cornicles, .066mm.; cauda, .060mm.; antennæ, joint III, .410mm.; joint IV, .205mm.; joint V, .175mm.; joint VI, .133mm.; filament, .130mm. On some specimens (the older ones) the orange-colored abdomen is very pronounced.

Described from six specimens collected November 12, 1912. Oakland, Cal., on *Q. robur* L.

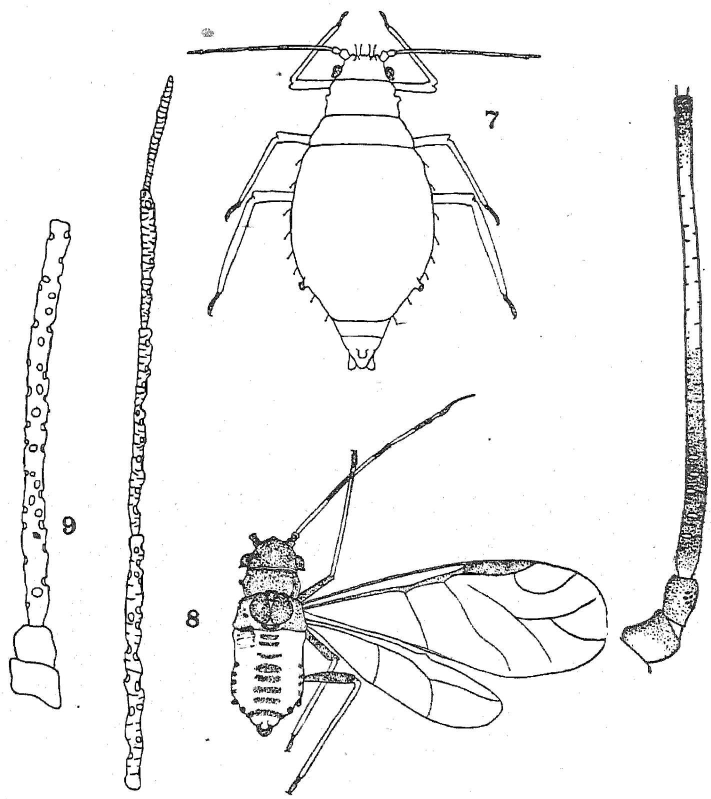

Fig. 3, *Myzocallis quercus* (?); 7, oviparous female; 8, winged male; 9, winged male, antenna.

Winged male: General color, pale yellowish-green; eyes, bright red; basal points of antennæ pale, distal joints, dusky or black; head, prothorax, last two abdominal segments, dark green, olivaceous; thoracic lobes, scutellum, cornicles, and seven transverse bars on abdominal dorsum, black; a row of black spots on each side of the abdomen; veins of wings narrow, brown; stigma, brown; stigmatic vein, entire; discoidals I and II, thick; legs, pale greenish-yellow; femora and tarsi, dusky brown. Sensoria as follows; III, 27–30; IV, 8–10; V, 9, 10; VI, 4, 5. Measurements: Body, length, 1.33mm.; body, width, .47mm.; wing expanse, 4.40mm.; cornicles, .028mm.;

cauda, .0316mm.; antennæ, joint III, .512mm.; joint IV, .297mm.; joint V. .255mm.; joint VI, .143mm.; filament, .145mm.

Described from four specimens collected October 25, 1912. Oakland, Cal., on *Q. robur* L.

I include this plant louse in this article in the hope that some aphidist can help me in the determination of the species. I can not identify it with any American louse and conclude that the species is European as it occurs only on oaks imported from Europe. The aphid seems to approach *Myzocallis quercus* Kalt. and I have listed it under this name in former papers (Journal Econ. Ent. August, '09 and August, '10). Also it is not this species, but another, that infests the native oaks.

Monellia caryella Fitch. Infests the under side of the leaves and the nuts of *Juglans californica* Watson. Collected at San José and Walnut Creek, Cal. Kindly determined by Prof. H. F. Wilson.

Aphis hougtonensis Throop. What seems to be this species infests and curls the terminal leaves of wild currant (*Ribes sanguineum* Pursh.) in the canyons of the hills of Contra Costa Co., Cal.

Aphis frigidæ Oestl.

Stem mother: Black or very dark green, covered with fine white bloom and short capitate hairs or spines. Antennæ black, reaching to base of cauda; joints II and III (except apex) yellowish-brown; eyes, black; first antennal joint somewhat gibbous;

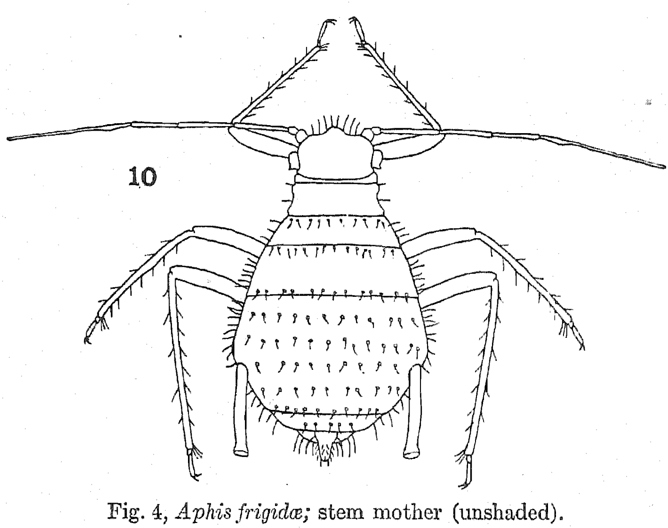

Fig. 4, *Aphis frigidæ;* stem mother (unshaded).

prothorax, with small blunt lateral tubercles; legs, black; anterior femora, yellowish-brown; cornicles, black, nearly four times as long as the cauda, their apices conspicuously flaring; cauda, dark green, ensiform. The young individuals are pale green with white pulverulence. Measurements: Body, length, 1.57mm.; body, width,

.87mm.; cornicles, .443mm.; cauda, .130mm.; antennæ, joint III, .26mm.; joint IV, .25mm.; joint V, .236mm.; joint VI, .125mm.; filament, .443mm.

Collected singly on *Artemisia californica* Less. at Walnut Creek, Cal., April 8, 1913. Colonies of *Macrosiphum frigidæ* Oestl., were present on the same plants. This latter species is never pulverulent.

Aphis atriplicis L.

Stem mother: General color, pale green; body covered with rather sparse white bloom; body, elongate-oval; head, eyes, legs, antennæ, cauda and cornicles, black or dark brown. Cornicles slightly exceeding antennal joint V in length, not much widened in the middle, somewhat curved. Cauda, tapering. Measurements: Body, length, 2.42mm.; body, width, 1.10mm.; cornicles, .097mm.; cauda, .136mm.; antennal joint III, .186mm.; joint VI, .077mm.; joint V, .088mm.; joint VI, .088mm.; filament, .126mm.

Described from several specimens collected April 7, 1913, Walnut Creek, Cal., in curled leaves of *Chenopodium murale* L. and *C. album* L.

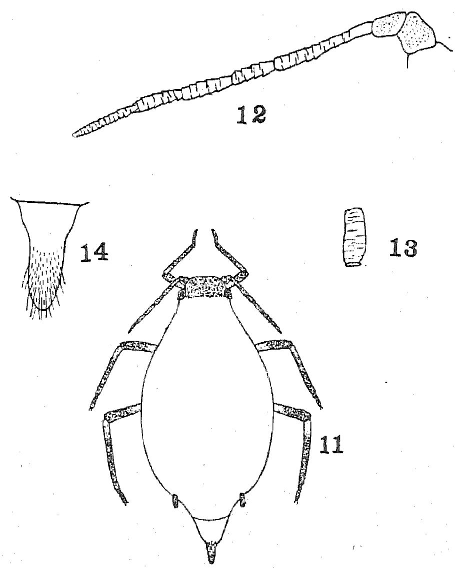

Fig. 5, *Aphis atriplicis;* 11, stem mother; 12, antenna; 13, cornicle; 14, cauda, of stem mother.

Aphis bakeri Gillette. During the fall and winter months I have collected this species in abundance on a large variety of plants, mostly Compositæ. It occurs on sunflowers, artichokes, *Gnaphalium, Senecio, Artemisia, Anthemis* and *Amsinckia.* It seems peculiar that a species inhabiting legumes and pomaceous fruits east of the Sierra Nevada Mountains, should have such a different range of food-plants on the Pacific Coast. I have never found this louse on either pomaceous fruits or clovers in California. Prof. H. F. Wilson[1] reports it from both these hosts in Oregon. The summer life history of the louse in California has yet to be fully studied. On German Ivy (*Senecio* sp.), at least, it seems to exist the year around and the annuals are infested by migrants from it. I am indebted to Messrs. J. J. Davis and H. Morrison for the determination of this species.

Hyadaphis xylostei Schank. Syn. *Hyadaphis conii* Davidson.

[1] Biennial Crop Pest and Horticultural Report 1911–1912, Oregon Agricultural College Experiment Station, p. 89.

(*Siphocoryne conii* Davidson "Notes on the Aphididæ in the vicinity of Stanford University;" Journal Econ. Ent. August, 1909). Close examination of specimens coupled with field observations have satisfied me that the species on *Conium maculatum* described by me as new is identical with the European honey-suckle louse.

Rhopalosiphum nervatum Gillette. A very abundant rose louse at Walnut Creek, Cal., attacking both wild and cultivated roses. I am indebted to Prof. C. P. Gillette for the determination of this species.

Rhopalosiphum corylinum sp. nov.

Winged viviparous female: General color, apple green; head and thoracic lobes, dark green; the former, with a brownish tinge; prothorax, darker than abdomen, but not so dark as head and thoracic lobes; scutellum, dark green; antennæ, longer than the body, on frontal tubercles, dusky green; joints I, II and extreme base of III, pale green; eyes, dark red; wings, of moderate size, venation normal; stigma, long and narrow, pale greyish-green; veins, dark brown; legs, pale green; femoral and tibial apices and tarsi, dusky grey; cornicles, nearly one-third the length of the body, slightly enlarged at distal two-thirds, base, pale; apical, two-thirds dusky; cauda tapering, the apex upturned, pale green; beak, reaches beyond second coxæ. Sensoria: Joint III, twenty-four to thirty, small, disposed along almost the entire length of the joint, circular; usual apical ones on joints V and VI. Measurements: Body, length, 2.16mm.; body, width, .83mm.; cornicles, .63mm.; cauda, .19mm.; antennæ, III, .80mm.; IV, .47mm.; V, .50mm.; VI, .143mm.; filament, .83mm. Described from many individuals.

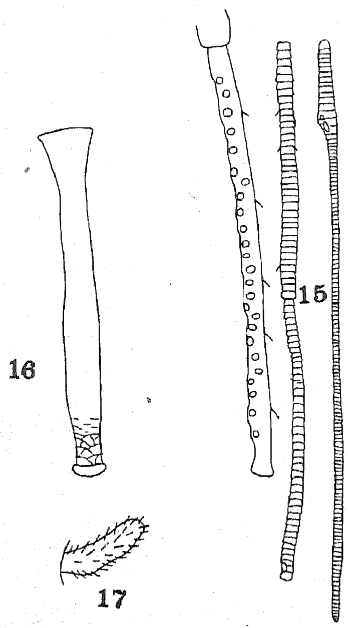

Fig. 6, *Rhopalosiphum corylinum;* winged viviparous female; 15, antenna; 16, cornicle; 17, cauda (from side).

The pupa, winged viviparous female: Pale green with a dorsal longitudinal stripe of darker green; antennæ, as long as body; articulations and whole of joints VI and filament dusky; elsewhere pale greenish-white; head, dark green; wing-pads, white; abdomen, often with orange-colored areas; cornicles, slightly thickened at distal two-thirds, pale greenish-white; legs, white; tarsi, dusky; cauda, pale, conical. Length of body, 2.44mm.; cornicles, .57mm. Described from numerous specimens. The apterous form is pale greenish-white.

This species infests the under side of the leaves and the terminal shoots of wild hazelnut (*Corylus rostrata* Ait.). Collected May 20, 1913, near Walnut Creek, Cal.

Myzus fragæfolii Ckll.

Oviparous female: General color, pale lemon yellow; older individuals, pale orange; Body spindle-shaped; antennæ reach base of cornicles, pale; two distal joints, dusky. eyes, very dark red; head, paler than the rest of the body with whitish powdery covering; whole body armed with short capitate spines; cornicles long, slender, slightly curving near the apex, cylindrical, white, the tip dusky; cauda, short, tapering, dusky. Measurements: Body, length, 1.42mm.; body, width, .66mm.; cornicles, .336mm.; cauda, .130mm.; antennæ, joint I, .088mm.; joint II, .051mm.; joint III, .314mm.; joint IV, .200mm.; joint V, .193mm.; joint VI, .080mm.; filament, .387mm. Described from many specimens.

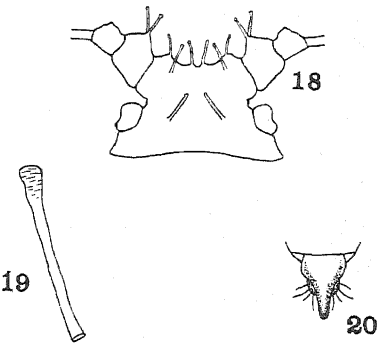

Fig. 7, *Myzus fragæfolii;* oviparous female; 18, head; 19, cornicle; 20, cauda.

Winged male: Head and thorax, black; abdomen, dark red with sparse whitish bloom and darker cross-bands on the dorsum; eyes and antennæ, black; dorsum of meso-thorax with white bloom; frontal tubercles and first antennal joint, porrect; front margin of head prominent; wings, extending far beyond abdomen; stigma, short, rather broad, white; second fork of third discoidal equidistant from first fork and wing apex; first fork equidistant from wing apex and origin of third discoidal; stigmatic vein short, curved deeply; insertions white; legs, pale yellowish-brown; knees, tarsi, base and apex of tibiæ, black; cornicles, long, narrow, cylindrical, dusky; cauda, one-third as long as cornicles, dusky, tapering. Sensoria as follows: Antennal III, about twenty small, irregularly disposed; antennal IV, about six similar; antennal V and VI, usual terminal. Measurements: Body, length, 1.20mm.; body, width, .43mm.; cornicles, .32mm.; cauda, .11mm.; wing expanse 5.54mm.; antennæ, joint III, .420mm.; joint IV, .254mm.; joint V, .254mm.; joint VI, .121mm.; filament, .478mm. Described from two specimens. *Eggs:* Black, shining, elongate, size .58mm. x .24mm.

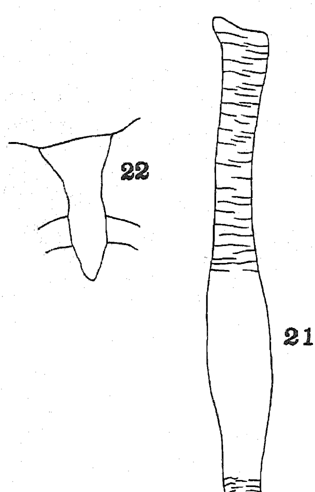

Fig. 8, *Amphorophora rubicola;* winged viviparous female; 21, cornicle; 22, cauda.

The sexed forms were observed in January and February, 1913, and were the predominant form during these months. The oviparous females far outnumbered the males. Eggs were deposited during these months on the lower surface of the strawberry leaves, and these hatched in March. At Walnut Creek, Cal., the species was observed to infest leaves and tender stalks of cultivated strawberries.

Phorodon galeopsidis Kalt. Infesting the under side of the leaves of *Polygonum* sp. Collected July 25, 1912, at San Jose, Cal.

Amphorophora rubicola Oestl.

Collected on the leaves and terminal shoots of thimble-berry (*Rubus nutkanus* Moc.), May 13, 1913, in hilly canyons of Contra Costa Co., Cal. At that date about 95 per cent. of the lice were large pupæ or recently transformed adults. The dusky spot at the apex of the wing, mentioned by Oestlund (Synopsis of the Aphididæ of Minnesota, 1887) was present in all alate specimens examined.

Macrosiphum ludovicianæ Oestl. What I take to be this species was observed infesting *Artemisia heterophylla.* The lice appeared first about February 6, 1913, at which date the plants were about eight inches in height. Toward the end of the month winged forms were produced and these migrated to other plants, the original centre of infestation in the area of plants under observation being confined to one plant. Several plants were destroyed by the lice settling in masses on the growing stalk but finally towards the end of April all the lice either left the area of plants under observation or were destroyed by enemies. Locality: Walnut Creek, Cal.

Macrosiphum rudbeckiæ Fitch. This louse in California seems to confine itself to the teasel (*Dipsacus fullonum* L.). I have collected it on many occasions in the vicinity of San Jose, California.

Additional Explanation of Figures

Camera lucida drawings, nos. 1, 2, 4, 9, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22-eyepiece no. 1, objective 16mm.; nos. 3, 5, 6-eyepiece no. 1 (tube 170mm.), objective 16mm.; nos. 7, 8, 11-eyepiece 1, objective 3in.; fig. 10-eyepiece no. 1 (tube 170mm.), objective 3in.

THE LIFE HISTORY OF THE SUGAR-BEET ROOT-LOUSE (PEMPHIGUS BETAE DOANE) [1]

By J. R. Parker, *Montana Experiment Station*

Considering how scanty is the knowledge of life histories in the genus Pemphigus, it is thought worth while to set before the entomological public the life history of the economically important species, *Pemphigus betæ* Doane. This species is the most important pest of the sugar beet in Montana and each year does considerable injury, the tonnage in badly infested fields sometimes being reduced a third. A study of its life history was begun as an Adams project in 1909, but not until the past summer were all the stages in its complex life cycle known.

[1] The investigations upon which this paper is based were carried on at the Montana Experiment Station as an Adams project under the direction of Professor R. A. Cooley, Station Entomologist.

This paper will deal only with the life history, while technical descriptions, studies in synonomy and a discussion of control measures will be reserved for future publication.

Wingless Viviparous Females—Virgogenia of European Writers

Early in the spring the full grown, subterranean, wingless, viviparous females which have survived the winter, begin to give birth to living young which also develop into wingless viviparous females. This rapid method of reproduction continues throughout the summer and is checked only by cold weather, lack of food or unfavorable soil conditions. A very wet spring may result in the death of all the hibernating lice, while in a dry spring they may feed and develop upon rootlets left in the ground from the previous season until the new crop of beets offers them more attractive food.

Wingless viviparous females have been found in Montana upon the following plants: very common upon pigweed (*Chenopodium album* L.) and sugar beets; common on table beets, foxtail (*Hordeum jubatum* L.) and salt grass (*Distichlis spicata* Greene); occasionally upon blue-joint (*Agropyron occidentale* Scribn.) and dock (*Rumex crispus* L.); rarely upon wheat, flax, alfalfa, and horseweed (*Iva xanthiïfolia* Nutt.).

Winged Fall Migrants—Sexupara of European Writers

From midsummer until late fall a part of the young which are produced by the wingless viviparous females develop wing pads and when full grown acquire wings and fly away. The conditions of the soil in regard to moisture has much to do with the number of winged lice that are produced. If the ground is kept moist or the rootlets of the host plant are succulent, few winged lice are produced, but if the soil becomes dry and the rootlets tough, the production of winged lice is greatly accelerated. In September and October when the beet fields generally become quite dry, the ground is sometimes almost black with the myriads of winged lice that have crawled up from the roots. Doane makes this statement: [1] "These winged individuals are the ones that provide for the distribution of the species, for after making their way to the surface of the ground, they sometimes fly for considerable distances. Having settled at the root of some plant, they soon begin to bring forth living young and thus a new colony, the winter colony, is established.

In Montana we have not observed this to be true. All of the many winged lice which we have confined in glass tubes have given birth to young which could not possibly start winter colonies. For several

[1] Page 8, Bulletin No. 42, Washington Experiment Station.

years we were in doubt as to where these winged lice went. They could be seen to fly away from the beet fields, but their destination was a mystery. The native cottonwood (*Populus balsamifera* Linn.) was suspected of being the alternate host, but not until September, 1912, were our suspicions confirmed. The insects were first noticed on the edge of a weedy field where *P. betæ* had previously been noticed in abundance upon the roots of pigweed, foxtail and blue-joint. As one looked across the field the air above it swarmed with winged lice which were flying toward a row of cottonwoods on the edge of the field. This row consisted of trees in three stages of leaf ripening. Some had lost nearly all their leaves, on others the leaves were still a dark green, while one tree at the end of the row retained its leaves which were a light yellow in color. To this last tree the majority of the lice directed their flight. Alighting on the leaves they immediately started down the stems to the main branches and down the main branches to the trunk. Every branch was gray with an army of winged aphids all marching in one direction,—down the tree. When the main trunk was reached, the lice crawled down until a suitable crack or crevice was found into which they would crawl. Many continued to the ground and secreted themselves in the leaves, grass, and dirt around the base of the tree. A loose piece of bark pulled from near the base of the tree revealed a mass of the winged lice clustered beneath it. Some were already dead with the abdomen shrunken clear to the thorax. Crawling over the dead bodies were small yellow lice and other winged specimens were observed giving birth to these small yellow individuals. The swarming continued until dark and was repeated on a smaller scale on warm, still days throughout the fall. Upon microscopic examination the great majority of winged migrants proved to be *Pemphigus betæ*, although a few specimens of a much larger undetermined species were also observed. .

Winged individuals have been collected from sugar beets, pigweed, foxtail and blue-joint.

True Sexes—Sexuales of European Writers

An examination of the small yellow lice deposited by the fall migrants showed them to be the true sexes. The females are nearly twice the size of the males and each contains a single large egg which shows plainly through the body wall. Each fall migrant gives birth to from four to seven individuals, the majority of which are females. One was observed to give birth to seven young in forty minutes. Both sexes have rudimentary mouth parts and take no food, but nevertheless four molts are passed through. The time of molting varies in different individuals but in nearly every case is completed at the end of four days after birth.

Sexual activity is not shown until the fourth molt after which the males crawl blindly about attempting to copulate with any female they can find. In from seven to twelve days after birth the female deposits a single, pale yellow egg and in a short time dies. Sometimes death occurs before the egg is extruded in which case the walls of the abdomen gradually shrink away finally leaving the egg exposed. Normally the female secretes a mass of bluish, white threads in which the egg rests after deposition.

Gillette has also reported finding the true sexes upon cottonwood in Colorado.[1]

Eggs

Eggs deposited by the sexual females remain in the crevices of the bark until the following spring, without change. By April 15, many of the eggs were turning darker in color and showed the eyes and a dark spot in the abdomen of the embryo. Hatching was first observed out of doors at Bozeman, May 3. The shell split near the head and by contractions of the body the young louse slowly forced its way out of the shell.

Stem Mother—Fundatrix of European Writers

The young lice hatching from the eggs crawl up the trees and cluster upon the expanding buds. As soon as the leaves unfold, feeding begins, generally on the upper side of the leaves in the angle between the mid-rib and the first or second vein. The resulting gall first starts as a depression at the point of attack, which gradually deepens and is finally closed from above by the growth of the leaf. The opening is a narrow slit or furrow parallel with the mid-rib or one of the large veins and scarcely noticeable from above. There is a high mortality among the immature stem-mothers. Out of thirty lice that were observed to start the formation of galls, only four lived to reach maturity.

Stem-mothers were first observed giving birth to young on the first day of June. The greatest number of young known to be borne by a single stem-mother was 172, while the average was about 75.

Winged Summer Migrants—Fundatrigenia of European Writers

All of the progeny of the stem-mothers developed wing pads and by June 20, some had acquired wings and were leaving the galls. By July 20, 90 per cent of the galls were deserted.

On July 3, a Pemphigus having all the structural characteristics of the winged individuals in the galls was observed on the leaves of Chenopodium, giving birth to young. The young at birth were enveloped in a

[1] Page 24, Twenty-fourth Annual Report of the Colorado Experiment Station.

membrane, but soon freed themselves and after wandering about on the leaf for a moment or two started down the leaf stalk and continued to the ground. This deposition of young upon Chenopodium was observed many times during the next two weeks and in every case the young lice proceeded directly to the ground.

On July 5, 250 plants of *Chenopodium album* were dug and their roots carefully examined for *Pemphigus betæ* colonies. Plants were examined on many parts of the college grounds, only one or two being dug in each locality. Sixty-five plants were found to be infested with colonies of *Pemphigus betæ* made up for the most part of very young lice. They were on fine rootlets that lay close to the surface of the ground and in most cases the ground was cracked so that they had easy access to the roots if they descended from the leaves. On August 5, a similar search was made and out of the same number of plants examined in the same localities, 151 colonies were found.

This, together with the fact that *Pemphigus betæ* seldom becomes abundant in the beetfields before the middle of July, has led us to believe that the principal source of infestation is the summer migrants, from the cottonwood galls.

Fifty migrants confined singly in glass tubes gave birth to a total of 480 young or 9.6 each. The greatest number produced by any one individual was 19. Young born to these migrants were placed upon sprouting sugar beet seed in germination cups; they began to feed immediately upon the fine rootlets. Others were placed upon the roots of the sugar beet plants growing in pots and in time developed into typical *Pemphigus betæ* colonies of wingless viviparous females. To avoid any chances of error, the roots of beet plants used in the experiments were dipped in "Black Leaf 40" and the soil used was carefully examined to see that it contained no root lice other than the young of the summer migrants.

The summer migrants, while resembling the fall migrants in general appearance, differ very materially in structure, a fact which seems to have been overlooked by most American workers in writing up other species in this group, but which has been especially noted by Tullgren, a Swedish writer.[1] The two principal differences in this species are in the number of sensoria on the antennæ and the absence or presence of wax glands on the thorax. In the fall migrants the arrangement of the larger sensoria is as follows: III 4–9; IV 2–3; V 0; VI 0. In the

[1] Aphidologische Studien Arkiv For Zoologi Band 5, No. 14.

The manuscript for this paper was submitted for publication November 8, 1913. In the December number of the Annals of the Entomological Society of America, volume 6, number 4, page 488, Professor C. P. Gillette has called attention to the marked difference which exists between the alate fundatrigenia and the alate sexupara of *Thecabius populimonilis* Riley.

summer migrant the arrangement is as follows: III 6–10; IV 2–3; V 2–5; VI 1–4. In the fall migrant paired wax glands are found upon the pro-, meso- and meta-notum, while in the summer migrants none are found upon any of the thoracic segments. According to the keys and descriptions of American writers these differences would surely place the fall and summer migrants in two distinct species and I believe that the summer migrant will prove to be an already described species, possibly *Pemphigus populicaulis* Fitch. Further study is needed before this point is decided.

Summary

Wingless viviparous females are found in the ground the year around upon the roots of beets, weeds and grasses.

In the fall winged individuals are produced which fly to cottonwood trees and deposit the true sexes.

The sexes mate and the female deposits a single winter egg in the crevices of cottonwood bark.

The following spring the young louse hatching from the egg ascends the tree, forms a gall, in which a single generation of lice is produced, all of which are winged and become the summer migrants.

The summer migrants fly to beets, weeds, and grasses and upon the leaves of such plants give birth to young which decend to the roots and start new colonies of winged viviparous females.

THE SAN JOSÉ SCALE IN NOVA SCOTIA

By Robert Matheson

Nova Scotia is the most easterly province of the Dominion of Canada, situated between 43° 30′ and 47° north latitude. It is almost completely surrounded by water, being connected to the mainland by a narrow strip of land only twelve miles wide. It is also deeply cleft by many bays and harbors so that no place is more than a comparatively short distance from the coast. It has an area of 20,500 square miles, a considerable portion of which is not well suited to agriculture. The northwestern portion of the province lies in the transition zone while the remainder has been placed in the Canadian zone. I do not think this represents in all cases the true distribution of the faunal zones of the province but this is due to our lack of knowledge of the local fauna. The section from Windsor to Digby lying between the north and south mountains forms the main fruit section and is spoken of as the "fruit belt." Here apples, plums, cherries and pears are grown extensively while peaches and grapes do fairly well in certain sections though not grown commercially to any extent. Small fruits

are also grown and this branch of the fruit industry is gradually being developed with the increase of market facilities. Other sections of the province, particularly the numerous river valleys on the south and north, are well suited to the growing of apples, plums, cherries and small fruits. Fruit growing is being generously aided by the government through the establishment of numerous model orchards, scattered one or more in nearly every county outside the recognized fruit belt. Over thirty-five of these are now established and it is hoped that encouraging results may be obtained within the next few years.

Many, in fact most, of the orchards throughout the fruit belt, more commonly known as the Annapolis Valley, consist of large, thrifty trees which have been in bearing for many years. Lately through the stimulus of large crops and good prices extensive plantings have been made and it will not be long before the fruit crop will have doubled and trebled. The production of apples is usually over 1,000,000 barrels per year while in 1911 an exceptionally good year; over 1,500,000 barrels were exported. Many of the progressive fruit growers predict a 5,000,000 barrel export crop within the next five years. This fruit belt has always been free from some of the worst fruit pests and up to within the last two years it was claimed that the province was entirely free from San José scale. The discovery of this dangerous orchard pest by Mr. George E. Sanders in the spring of 1911 aroused widespread interest and misgivings as to the future of the fruit industry. Living scale was found on nursery stock planted the preceding year proving that this scale could survive the winters in Nova Scotia.

There has been considerable discussion as to the northern limits of San José scale. However, this dangerous fruit insect is gradually moving northward, particularly in Ontario and New York, where it is now working slowly into the transition zone. Professor Caesar, provincial entomologist of Ontario, informs me that it has not yet become established in Ontario beyond the northern limit of the upper austral zone as laid down by C. H. Merriam, and he thinks it will not thrive beyond this. The fruit belt in Nova Scotia is at present entirely in the transition zone but further faunal studies may change this and I think it will. For the past nine years the average of the minimum temperatures for the most northerly point of this fruit belt (Windsor) is $-11.5°$ while the lowest temperature during the same time is $-18°$. The average maximum temperature for the same period is 90.5°, the highest temperature being 96°. A few miles further west at Wolfville, N. S., the average minimum temperature covering a period of eight years is $-9.2°$, the lowest being $-14°$. The average maximum temperature is about the same as for Windsor.

In Nova Scotia the scale has survived the winters but at present there

is no data regarding the winter mortality. Experiments have been started at Truro, N. S., on the effects of climatic conditions on this scale but no results are as yet available. During the past summer scale-infested trees were under constant observation and the number of generations up to the first of October was carefully observed. The first adult male was taken in our outdoor breeding cage, which consisted of four partially infested young apple trees enclosed in wire netting so as to prevent distribution, on June 23. The spring was cold and backward but the female scales were growing rapidly and many male pupæ were ready to transform. On July 26 the first living young were observed and within the next ten days many of the young lice could be seen crawling over the trees and settling down. The weather during the latter part of June was very cold, a severe frost on the 22d having destroyed many tender plants and here and there young potato plants. The first generation were hatching in abundance about August 7. The trees were now becoming well covered with the maturing scales. On August 22 we had another sharp frost killing such plants as tomatoes, squash, cucumber, corn, and in some places blackening fields of maturing potatoes. However, the scale seemed to thrive and the second generation began moving about September 3 and continued abundantly for the next four weeks. On October 12 young lice were still hatching but whether this was the last of the second generation or beginning of the third I could not determine. However, the season of 1913 was an exceptionally cool and backward one in Nova Scotia, a similar one not having been experienced for many years previously. The spring was late and cold while severe frosts occurred late in June and rather early in August, a condition seldom occurring. Yet despite this there were two full generations of the San José scale and I feel that under normal conditions there will always be at least a partial third generation. As to whether the majority of the scale will winter or not is yet to be learned. The minimum temperature at Truro, N. S., rarely goes to $-25°$ F. though during the winter of 1912–1913 the lowest recorded was $-27°$ F.

Following the discovery of living San José scale, active measures were at once taken by M. Cumming, Secretary for Agriculture. Fortunately an insect pest law, drawn in broad terms, had been enacted in 1911 and under its provisions a thorough inspection of all nursery stock imported during the years 1910, 1911 and 1912 was begun. Lists of consignees were obtained from nearly all the nursery firms that had done business in the province. These lists furnished a basis for the work. Mr. George E. Sanders, of the Dominion Entomological Staff, took charge of the work and pushed it energetically. The results of this work are shown in the following pages.

It is not the purpose of this paper to outline the regulations that have since been passed governing the admission of nursery stock into the province. Suffice it to say they are quite adequate to keep out all infested stock if properly enforced. During the spring of 1913 the

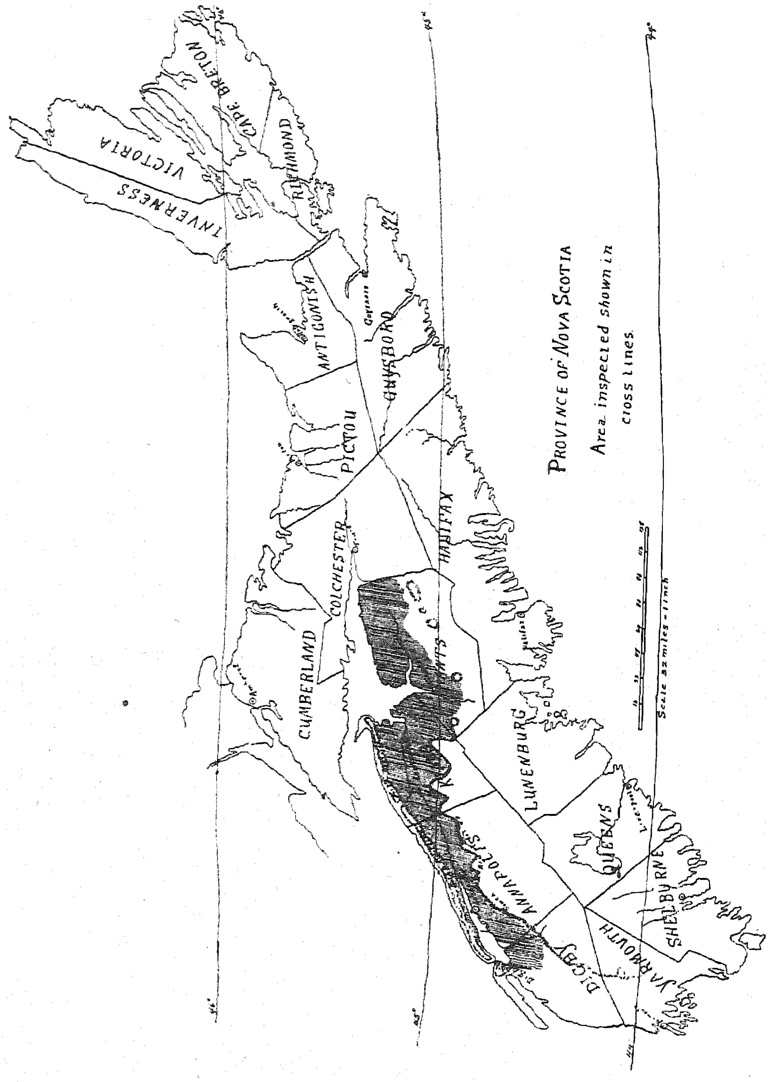

Fig. 9. Map of Nova Scotia showing inspected area.

writer determined to inaugurate a thorough inspection of the entire fruit belt. It was determined to pursue the policy of the preceding year,—to destroy all infested trees and if possible to exterminate the scale. I feel the results have justified the expenditure and it would

seem that it is now possible to completely eradicate this pest or keep it so in check that there will be no danger of the old orchards becoming infested. The plan pursued was to have inspectors visit every farmhouse and garden throughout the district shown in cross lines on the map in Fig. 9. This actual field work was in charge of Mr. H. G. Payne and under him were eight competent inspectors. The inspectors worked in pairs and every inch of ground was carefully gone over. They were required to give information on the following points, the accuracy of these answers depending largely on the ability of the inspectors:

Name, address, origin of stock; trees destroyed, 1910, 1911, 1912, 1913; number inspected; acres in orchard; spraying, cultivation, and condition and general remarks.

As they knew the country thoroughly and were all acquainted with local conditions the results may be considered as fairly accurate. We found the people only too willing to aid us, and no particular difficulty in securing the information required was met with.

Results of the Inspection Work

	1912	1913	
Number of properties inspected....................	1,758	5,042	
Number of trees inspected................(estimate)	150,000	166,000	(actual count)
Number of properties infested (including dead scale)..	793	123	
Number of trees of 1910 planting destroyed.........	7	0	
Number of trees of 1911 planting destroyed.........	339	6	
Number of trees of 1912 planting destroyed.........	377	45	
Number of trees of 1913 planting destroyed.........	—	6	
Total number of trees destroyed..................	723	56	

A comparison of the results of the two seasons' work shows gratifying results especially when one considers that during 1913 a much larger area was inspected and many more trees were carefully gone over. This also included the entire 1913 planting. The results of another year's work may actually demonstrate the practical eradication of San José scale from this restricted fruit belt.

In order to secure data for future recommendations I had the inspectors obtain as accurate answers to the other questions as possible. As I know of no other similar survey of a district which has been producing fruit for over 100 years I here offer these results which may prove of interest to many entomologists.

Total number of properties inspected..............................	5,042
Total acreage (approximate) in orchards..............................	31,203
Number of fruit growers who spray at least once (we did not request the number of sprayings)..	2,378

Number of fruit growers who do *not* spray	2,664
Percentage of fruit growers who spray	47.3
Acreage of orchards sprayed at least once	23,311
Acreage of orchards *not* sprayed	7,895
Percentage of orchard area sprayed	74.7

This data is for the whole district shown in cross lines in Fig. 9. It may further be remarked that the inspectors were careful in securing acreage and all areas down to one eighth or one sixteenth or even smaller fractions of an acre were included. Furthermore, all the men had had caréful training in estimating areas so that the results may be taken as fairly accurate, much more so than the best of census returns. In regard to the results as to spraying our men had to be careful in questioning property owners as there had been considerable agitation for an out and out compulsory spray law, compelling every one to spray according to a more or less fixed schedule. The inspectors took careful note of the condition of the trees and also looked around carefully for signs of spray outfits or spray materials before venturing to inquire too closely,—so these results may be looked upon as accurate as can be obtained.

Further, this fruit belt is divided into counties as shown on the accompanying map. Kings County has always proclaimed itself as the most up-to-date fruit section, so with considerable clerical labor I had the results tabulated as to counties and this will undoubtedly prove of interest as showing what may be done by progressive fruit growers in a particular district or county.

Counties	Hants	Kings	Annapolis	Digby
Number of trees inspected	10,704	102,195	52,117	818
Number of trees destroyed	15	36	5	0
Number of properties inspected	532	2,735	1,631	144
Number of fruit growers who spray	117	1,729	525	7
Number of fruit growers who do *not* spray	415	1,006	1,106	137
Percentage that spray	21.9	63.1	32.2	4.8
Total average in orchards	2,372	20,435	8,118	281
Acreage sprayed at least *once*	1,015	17,652¾	4,601	41¼
Acreage *not* sprayed at all	1,357	2,782¼	3,517	239¾
Percentage sprayed	43	86¼	56¾	14½

In examining these tables one must not forget that the number of trees inspected only covers those trees planted in 1910, 1911, 1912, and 1913. It will readily be seen from consulting and comparing these tables that it is the smaller orchardists that usually do not spray, though this is by no means always the case. These small orchards scattered all over the district furnish ideal breeding grounds and centers for dispersal of injurious insects or fungous diseases. There has been considerable agitation for a general compulsory spray law but whether it would work out successfully in such a district is rather

doubtful as at present there are a goodly number of people who are opposed to spraying in any form.

A NATURAL ENEMY OF THE ARGENTINE ANT

By Wilmon Newell, *College Station, Texas*

The phenomenal abundance of *Iridomyrmex humilis* in the southern parts of Louisiana and Mississippi is doubtless explained by the absence of both parasites and predaceous enemies. During the ten years in which this ant has been under almost constant observation no enemies of importance have been observed until recently.

During September last Mr. R. S. Moore, an extensive orange grower in the Louisiana citrus-growing section, sent to the writer specimens of an ant which he had found very active in raiding the colonies of *Iridomyrmex humilis*, destroying adults and carrying off the larvæ and pupæ of the latter. The specimens were thought to be one of the legionary ants, *Eciton* (*Acamatus*) *schmitti* Emery, and this was subsequently confirmed by Dr. W. M. Wheeler upon examination of specimens.

Mr. Moore is, fortunately, a very close observer and is not without considerable reputation locally on account of his intimate knowledge of all the common injurious insects of the orange groves. During the past year Mr. Moore has frequently observed the Ecitons in their foraging expeditions and gives a graphic account of the thorough manner in which their pillaging colonies destroy practically all the individuals of *I. humilis* in the territory which they raid. In fact, in some of the orange groves which were formerly threatened with complete destruction on account of the great abundance and activities of *humilis*, and which have been favored with several visits of the Ecitons, hardly a specimen of the former species can now be found.

The territory in which the Ecitons have thus been active is upon the west bank of the Mississippi River below New Orleans, where the only arable land is a narrow strip just within the levee. The entire territory is practically surrounded by water, the river being on the east side and a constant succession of swamps and bayous occurring on the west from opposite New Orleans to Barataria Bay on the Gulf of Mexico. It seems hardly probable that the migratory Ecitons will be able to leave this area on account of the water barriers. One is, at the same time, forced to the conclusion that the species has been established there for many years past and that it is increasing in numbers on account of the great abundance of the Argentine ant. It is also interesting to note that this, the first important enemy of the Argentine ant to be discovered, is a native form operating against an introduced species belonging to the same family as itself.

A NEW COTTON SCALE FROM PANAMA

By T. D. A. Cockerell

A few weeks ago Mr. E. Bethel of Denver kindly forwarded to me some Coccidæ collected in the Panama Canal Zone by Mr. James Zetek. One of the species was seen at once to be a new *Icerya;* and as this genus is of more than ordinary interest, both from the economic and purely scientific points of view, the insect is described herewith.

Icerya zeteki n. sp.

On stems of an undetermined plant, having dark red color externally and much white pith within.

Female. Oval, about $4\frac{1}{2}$ mm. long, densely covered with white cottony tufts' slightly stained with yellow; an elongated central mass of white wax is surrounded by a channel or depression, except anteriorly, and this is margined by a series of low quadrate tufts, about seven on each side, separated from each other only by slight depressions; outside of these, not separated by any interval, are low subquadrate tufts, about 10 on each side; in front is a suberect, horn-like but truncate, waxy projection, one mm. or more long; while posteriorly a similar waxy projection, but much longer (up to 4 mm.) projects over the ovisac, from which it is quite free. Ovisac 3–$3\frac{1}{2}$ mm. long, very strongly fluted, white suffused with pink. No glassy filaments. Legs and antennæ piceous. The measurements of legs and antennæ are in microns. Anterior legs: femur with trochanter, 640; tibia 512; tarsus with claw 272. Antennæ 11-jointed, third joint longer than broad, fourth broader than long. Joints measuring (1.) 80 (2) 96, (3.) 104, (4.) 72, (5.) 64, (6 to 10) each 80, (11.) 160.

Larva light raspberry color; antennæ 6-jointed, the joints measuring (1 to 5) each about 50, (6.) 160; last joint or club with no swelling at base; longest bristles on antennæ about 830 μ; three pairs of long straight bristles on each side of caudal end, the longest 1360 μ long (the body of the larva being only about 750); anterior to these are two very long curled bristles, then three shorter curled ones, then much shorter straight ones.

Closely allied to *Icerya brasiliensis* Hempel, but with the anterior and posterior waxy processes shorter, and wholly without the lateral posterior processes, on each side of the long one, which are so conspicuous in *I. brasiliensis*. In the larva of *brasiliensis* the posterior curled bristles of abdomen are not longer than the anterior ones. The ovisac of *brasiliensis* is creamy white, not pinkish.

ACAROLETES PSEUDOCOCCI n. sp.

By E. P. Felt, *Albany, N. Y.*

This interesting midge was reared in 1913 by Prof. H. J. Quayle from *Pseudococcus citri* Risso collected by him in Sicily. It is tentatively referred to the above named genus though it seems to have no very close affinities with *A. tetranychi* Kieff., the generic type. We are

unable to refer it to any described species, and the form is therefore characterized as new.

Male. Length 1.5 mm. Antennæ probably as long as the body, sparsely haired dark brown; 14 segments, the fifth with the stems, each with a length about twice the diameter; terminal segment missing. Palpi; first and second segments short, irregular, the third with a length about four times its diameter, the fourth ¼ longer than the third, the distal two thirds dilated. Mesonotum yellowish brown. Scutellum, post-scutellum and abdomen fuscous yellowish. Halteres yellowish basally, fuscous apically. Coxæ and femora basally yellowish, the distal portion of femora, tibiæ and presumably tarsi, fuscous straw. Genitalia; basal clasp segment rather long, moderately stout and internally at the basal angle with a long, narrowly triangular lobe, the latter slightly curved apically; terminal clasp segment moderately long, slender; dorsal plate short, triangular, emarginate, the lobes broadly rounded; ventral plate short, broad, narrowly and irregularly rounded; style short, tapering to a narrowly rounded apex.

Female. Length 1.5 mm. Antennæ extending to the third abdominal segment, sparsely haired, fuscous yellowish; 14 segments, the fifth with a stem ¼ the length of the cylindric basal enlargement, which latter has a length 2½ times its diameter; terminal segment slightly produced, with a short, stout process apically. Palpi practically as in the male, except that the third and fourth segments appear to be nearly equal. Mesonotum purplish brown. Scutellum and post-scutellum yellowish brown; abdomen sparsely haired, deep red. Halteres yellowish basally, fuscous apically. Coxæ and femora basally yellowish, distal portion of femora, tibiæ and presumably tarsi, fuscous straw. Claws stout, strongly curved, bidentate, the pulvilli as long as the claws. Ovipositor short, obtuse, the terminal lobes narrowly oval and sparsely setose. Type Cecid a2469.

This species presents a close general resemblance, both in antennal and alar characters, to Arthrocnodax from which it is most easily separated by the bidentate claws. The internal lobe of the basal clasp segment suggests a relationship to Coquillettomyia Felt, though there is no marked chitinization of the ventral plate or harpes so pronounced in this genus.

AMMONIA GAS AS A FUMIGANT

By D. E. Fink, *Assistant, Truck Crop and Stored Product Insect Investigations, Bureau of Entomology.*

Ammonia has never been the subject of experiment as a fumigant so far as the writer can learn, at least in recent years. It first suggested possibilities in this direction when through accident the fumes were inhaled. Its properties as a disinfector add to its value, particularly when used on food products.

While the sources of ammonia are many, at the time the experiments were begun only one source was found available, viz., the "concentrated ammonia" obtained in drug stores, and said to contain 27 per cent of ammonia in solution. It is readily seen that in the use of this form it is necessary to handle practically three parts of water every time one part of ammonia gas is desired.

EXPERIMENT 1

July 1, 1913, six quart bags containing cow peas previously sifted of all dead weevils and having only live weevils present were placed in a fumigation box of $8\frac{2}{3}$ cubic feet capacity. Two ounces of concentrated ammonia were used.

July 2, the results were as follows:

	Dead	Alive	Per cent Killed
1	57	6	90
2	85	16	84
3	96	33	74
4	66	9	88
5	9	7	56
6	81	39	67

EXPERIMENT 2

July 2, 1913, six quart bags of cow peas containing living weevils as in the previous experiment were subjected to 3 ounces of concentrated ammonia in the same fumigating box.

July 3, the results were as follows:

	Dead	Alive	Per cent Killed
1	42	0	100
2	61	0	100
3	74	1	99
4	64	0	100
5	52	0	100
6	25	0	100

Further experiments were undertaken with a 50-pound bag of cow peas which, with 3 ounces of the concentrated ammonia and an exposure of 48 hours, gave from 75 to 85 per cent of weevils killed.

Experiments were tried with a 100-pound bag, the amount of concentrated ammonia being increased to 1 ounce to the cubic foot, but even this amount failed to give a high mortality. Further experiments with ammonia are under way to ascertain its value as a fumigant against household insects and stored product insects on a large scale.

A NEW SPECIES OF KERMES FROM CONNECTICUT

By GEO. B. KING, *Lawrence, Mass.*

Kermes waldeni, n. sp. Adult female scale: Globular, 5 mm. in diameter, shiny. Surface, yellowish brown, with four transverse very dark brown bands on the meson, and marbled with brown somewhat darker than the general surface color. Some of the marblings are circular. The surface is also marked with some dark brown dots,

and some specimens show a few small pits. The coloring and markings are extremely variable, more so than in any other species yet described.

The individuals of this species show a marked tendency to cluster around the forks of the twigs, whereas those of most other species found in Connecticut occur sparingly or singly.

On *Quercus* sp. Portland, Conn., August 12, 1913, collected by Mr. B. H. Walden after whom I take pleasure in naming the species.

In preparing a work on the genus *Kermes* in order to give exact geographical distribution, I have written to entomologists in every state from which *Kermes* has been recorded. The first response came from Dr. W. E. Britton of New Haven, Conn., who sent me all the material in the collection of the Agricultural Experiment Station. This material contained the species described above, as well as other species which I have identified as follows:—

Kermes pubescens Bogue, on *Quercus* sp., New Haven, Conn., August 20, 1908, H. L. Viereck; June 27, 1913, W. E. Britton.

Kermes kingii Ckll., on *Quercus* sp., New Haven, Conn., August 20, 1908, H. L. Viereck; August 26, 1913, Q. S. Lowry, November 11, 1913, B. H. Walden.

Kermes sassceri King. MS., on *Quercus* sp., Putnam, Conn., April 17, 1906, B. H. Walden; New Haven, Conn., July 26, 1906, October 12, 1908, November 11, 1913, B. H. Walden; August 26, 1913, Q. S. Lowry; Meriden, Conn., August 27, 1913, Harry Johnson.

CANADA PROHIBITS IMPORTATION OF NURSERY STOCK THROUGH THE MAILS

By an Order-in-Council of December the 4th, 1913, the following amendments to the Regulations under The Destructive Insect and Pest Act were passed:

In Regulation 3, line 14, the words "Importations by mail shall be subject to the same Regulations" were struck out and the following new Regulation, No. 18, has been passed:

"18. The importation of all nursery stock, including trees, shrubs, plants, vines, grafts, scions, cuttings or buds through the mails is prohibited, excepting green-house grown florists' stock, cut flowers, herbaceous perennials, and bedding plants, which will be admitted provided that a detailed statement of the contents is attached to such parcels."

This Regulation is to take effect on and after the first day of March, 1914.

C. Gordon Hewitt,
Dominion Entomologist.

Scientific Notes

Concerning Remedies for Chiggers. While in conversation with the late E. F. Erwin, of the Department of Agriculture, concerning remedies for "chiggers" (*Trombidium* spp.) the writer mentioned the value of cattle and even of the passing of many persons in destroying the pests by trampling them. This is printed in the last paragraph of Circular 77, of the Bureau of Entomology, page 66, but where the subject is considered from the standpoint of infestation to a limited tract.

Mr. Erwin stated that when we have to deal with a badly chigger-infested tract of, say 400 acres, he considered cattle inadequate and cited his own experience on such a tract, that after turning sheep into the field that the chiggers were destroyed. Undoubtedly this was largely due to their being trampled to death, and to the sheep keeping the grass more tightly cut than would cattle, but Mr. Erwin also believed that the chiggers ascend the limbs of the sheep and that the oil in the wool is responsible for their demise.

Whatever may be the truth, it is obvious that sheep turned into large tracts of infested land would probably accomplish the eradication of the mites more thoroughly and in a shorter space of time than would perhaps any other domestic animals that might be employed for the purpose with the possible exception of goats.

F. H. Chittenden, Sc.D.,
Bureau of Entomology, U. S. Department of Agriculture.

The Colorado Potato Beetle Migrating to the Pacific Coast. Early writers on the distribution of the Colorado potato beetle (*Leptinotarsa decemlineata* Say) were of the opinion that this species would not be able to become disseminated westward of Colorado. In later years we have found that many species become distributed from west to east as well as from east to west. In other words, we cannot lay down "hard and fast rules" in regard to a great many forms of insects. This matter was summed up by the writer in 1907.[1] "As was predicted years ago, the Rocky Mountains have proved an impassable barrier for this species, and the insect had not been able to reach the Pacific Coast or neighboring states west of such barrier." It was, therefore, a considerable surprise to receive specimens of this beetle in somewhat cramped condition, owing to their being tightly pressed, with larvæ, into a small tin box. The beetles show no particular difference from the typical *L. decemlineata.*

It seems more than probable that this species has made its way so far westward through the agency of man or by what Doctor Howard has termed a "commercial jump," and it may now be expected anywhere west of the Rocky Mountains, since we know of its occurrence in Colorado 8,000 or more feet above sea-level. The specimens were obtained from Sister M. Rose, Order of St. Benedict, Colton, Washington, who kindly furnished them by request.

F. H. Chittenden.

On a Food-habit of Alabama argillacea. Mr. Charles Alkire, an orchardist of Keyser, Mineral County, W. Va., reports that the moths of *Alabama argillacea* did serious damage to late peaches in his orchard in the fall of 1911 and again in 1912. He states that the moths punctured the skin of the ripe fruit and fed on the juice, the puncture being very small and not noticeable until the bloom or fuzz was rubbed from the skin. The injured fruit would be normal in appearance until picked, when it would be found to have soft spots about an inch in diameter surrounding the punctures. These rendered it unfit for packing and shipping and even for local use.

[1] Circular No. 87, Bureau of Entomology.

The varieties injured were late clings and the extent of the injury was as great as 75 per cent. Only comparatively few trees were affected for the reason that not many of the late varieties were in bearing at that time. There appears to be no doubt as to the responsibility of the moth in question as Mr. Alkire states that he, personally, has observed the moth at work and that several of his workmen have also seen it. He submitted samples of the moths, so there is no doubt as to the identity of the species.

Spilogale feeding upon Peach-tree borer pupæ. Mr. Alkire also called attention to the value of the common pole-cat (*Spilogale interruptans*) as an insect destroyer. He states that in worming peach trees, especially in August, he has repeatedly found traces of this animal and has seen where it had removed the pupæ of the peach-tree borer from the soil, and that one afternoon he, with several workmen, was worming trees and saw the pole-cat going from tree to tree and searching for the pupæ which it dug out and devoured.

L. M. PEAIRS, *Morgantown, W. Va.*

Occurrence of the Argentine Ant in Texas. On January 5, 1914, the writer visited Beaumont, Texas, and found a heavy infestation by *Iridomyrmex humilis* Mayr. throughout a considerable portion of the business and residential sections of the city. The evidence of citizens interviewed indicates that the insect has been established in this locality for the past five years and the infestation is fully as heavy as at points in Louisiana and Mississippi which have been infested for a similar period.

The occurrence of the ant at this point, on the main line of the Southern Pacific Railway, confirms previous observations to the effect that most rapid dissemination takes place along the lines of heavy railway traffic.

WILMON NEWELL.

College Station, Texas.
January 7, 1914.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

FEBRUARY, 1914

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—Eds.

Separates or reprints will be supplied authors at the following rates:

Number of pages	4	8	12	16	32
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Some contributors fail to realize the importance of sending in papers promptly after the annual meeting or the need of returning proof without loss of time. These hindrances have made it impossible for the editor to get out this number on time.

Those who were able to attend the Atlanta meeting found a most interesting program and a larger attendance than many had anticipated. The papers covered a wide range of subjects and contained much that was suggestive. A notable contribution was the account of the large scale control of grasshoppers in a western state as a result of using the resources science has placed at the disposition of man. It was a problem in organization and coöperation as well as one depending upon exact knowledge of methods. Those who engaged in this practical effort, a game in which the resources of man, were pitted against the multitudes of nature are to be congratulated upon winning a fight which only a few years ago would have been considered nearly hopeless. It was a most creditable triumph of modern science.

Committee reports are ordinarily disposed of in a few moments and, in many instances, we fear, ignored thereafter. This should not be the fate of the report of the committee on the Efficiency of Entomological Publications. The members have spent considerable time upon the matter and though the nature of the problem was such that definite conclusions are almost impossible, the data gathered is most suggestive and might well be subjected to further test by every member of the association as opportunity offers. The popular bulletin, elementary in nature from the entomologist's viewpoint, is the one most generally valued, particularly if comprehensive and well illustrated. It is quite possible that further consideration of the question will result in more popular bulletins being widely distributed and a carefully limited circulation of the more special or technical publications.

The latter are the important issues from the scientific standpoint and must ever form the basis of any satisfactory progress. Research work must be available though not necessarily in the hands of everyone. Adjustments in dissemination may be advisable as well as in presentation.

Obituary

EDWIN ALONZO POPENOE

PROFESSOR EDWIN ALONZO POPENOE, A. M., for many years professor of entomology in the Kansas State Agricultural College at Manhattan, and entomologist of the Station, died in November, 1913.

Professor Popenoe was born July 1, 1855. He was the first professor of entomology at the Kansas Agricultural College and was made entomologist with the establishment of the Station by the Hatch Act in 1887. For several years the chairs in entomology and horticulture were combined, but later were separated and Professor Popenoe was continued as Professor of Entomology. He was a man of quiet and retiring disposition, a great reader, and well posted on many subjects, and was loved by his students and friends.

When he retired from active teaching, about six years ago, he purchased a fine farm five miles south of Topeka where he raised many flowers, specializing in iris and peonies.

Professor Popenoe married Miss Flora Hyde who died in the eighties. He afterwards married Carrie Holcomb, who with four sons, survive him. Charles H., is in the Bureau of Entomology, Division of Truck Crops and Stored Product Investigations; Hubert teaches agriculture in a Minnesota school; Edwin A., Jr., manages the home farm; Willis P. is still a boy in school.

Professor Popenoe was for many years a member of this Association. His death was said to be due to a clot of blood at the base of the brain, the result of overstraining.

W. E. B.

ALFRED GOTTLIEB HAMMAR

ALFRED G. HAMMAR, entomological assistant of the Bureau of Entomology of the United States Department of Agriculture, was accidentally shot and instantly killed, while on a hunting trip near Roswell, N. M., October 15, 1913.

Mr. Hammar was born May 19, 1880, at Bromestad, Sweden. As a boy he was much interested in natural history and at the age of sixteen, full of desire to study first-hand the tropical fauna of which

he had read marvelous accounts, he went to Brazil. There he obtained employment in a drug store in the state of Sao Paulo and immediately improved his opportunity to study not only the zoölogy, but also the botany of the region. He quickly attracted the attention of prominent scientific workers and, before long, secured a position with the Commissoa Geografica e Geologica of Sao Paulo, in the division of botany and meteorology. He also accompanied a German scientific expedition on an exploring trip through parts of Brazil.

His interests had always been along entomological lines and he showed so much promise that his chief, Orville A. Derby, advised him to go to Cornell to study with Professor Comstock. This he did, arriving at Ithaca in the spring of 1903.

Though Mr. Hammar was handicapped by the facts that he knew practically no English and that he was wholly self-supporting, his ability and zeal were such that he completed his course with honor in the minimum period and graduated with the class of 1907, taking the B. S. A. degree. He was then appointed assistant in entomology at Cornell, and, carrying on his graduate work in the summer of 1907 and the following year, received the degree of Master of Arts in 1908.

In the spring of 1908 he secured a position as special field agent with the Government Bureau of Entomology and very soon was regarded as one of the most reliable and promising of the young men in the service. He was given assignments of increasing responsibility and on April 1, 1913, was advanced to the rank of entomological assistant. From March, 1912, until the time of his death he was in charge of an important substation maintained in New Mexico.

He had been married, only two months before his death, to Miss Marion Hornor of Parkersburg, W. Va. He and his bride were to have left in a few days to visit her parents in West Virginia and from there they were to sail for Sweden, his boyhood home.

Mr. Hammar was by no means a narrow specialist but was broadly trained and interested. He was a skilled artist, and used readily seven different languages. While at Cornell he was prominent in student activities. He was one of the organizers and leading spirits of the Cosmopolitan Club and editor of the first *Cosmopolitan Annual.* He was also active in the organization of the Agassiz Club, a member of Sigma Xi and of the graduate scientific fraternity, Gamma Alpha.

His career as a student afforded a clue to the traits which were of such an aid to him in all of his subsequent work, and which promised to put him very early in the front ranks of entomological workers. Well trained, keen and thorough, he possessed in addition, the personal traits which won the esteem and confidence of all with whom he came in contact.

This last characteristic is nowhere better shown than in the history of his work in New Mexico. As stated by those on the ground, "Hundreds of thousands of dollars had been invested in apple orchards in Chaves County which, originally free from all sorts of common pests, contained every element of promise to become the greatest deciduous fruit section in irrigated America."

The pests did not neglect their opportunity, but it is easy to understand that this young man, sent to investigate pests whose existence was not openly acknowledged, was coldly received. The imputation behind his detailment was resented and few there were who saw the great importance of the work which he took up. Such a condition demanded more than technical knowledge—it called for tact and a winning personality that are not easily found. As to how fully Mr. Hammar measured up to the situation, let the following quotations from a memorial by the Roswell Commercial Club speak:

"It was not until the spring of 1913, the present year, that the growers began to realize that they had such an asset in the Bureau of Entomology and Professor Hammar. The calls upon his time were numberless and he visited and advised in hundreds of orchards. Usually his advice was carefully followed and, wherever it was, the benefit to the trees and the fruit was positive and immediate."

"This Club, making an average from the estimates of the various growers, marketing associations, and exchanges, estimates the value of Professor Hammar's services to the county of Chaves, alone, this year to have been not less than a quarter of a million dollars. This relates solely to the increased quantity and improved value of the fruit, and in no sense to the value of the imparted knowledge, improved condition of the trees, etc., which can scarcely be estimated."

Such was the man who has gone out from us. He was an entomological expert, but he was more. Wherever he went he was beloved and to the many who knew him, his death is felt as a personal loss. It is worth while for an entomologist to have won from a community of energetic, hustling business men the closing paragraph of the letter above quoted:

"We will only say that our knowledge of Mr. Hammar was such as to impel the belief that constant contact with the heart of nature breeds a sublimity and yet a sweet simplicity of character that ennobles the process of government and inspires a wholesome reverence for the works of God and his natural laws."

WM. A. RILEY

Current Notes

Conducted by the Associate Editor

Colonel W. C. Gorgas has been appointed by President Wilson, surgeon-in-chief of the United States Army.

Dr. C. Gordon Hewitt, Dominion Entomologist of Canada, has been elected a corresponding member of the Zoölogical Society of London.

Mr. C. H. Richardson is assistant in entomology at the Agricultural Experiment Station, New Brunswick, N. J.

Mr. G. H. Hollister, superintendent of Keney Park, Hartford, Conn., was recently elected pomologist of the Connecticut Horticultural Society.

Mr. W. O. Hollister, formerly entomologist of Parke Davis & Co., Detroit, Mich., is now connected with the Davey Institute of Tree Surgery, Kent, Ohio.

J. Robert Parker, assistant entomologist at the Montana Station, made a short visit at his home in Windsor, Conn., and at Amherst, Mass., during November.

Mr. A. J. Spangler, formerly assistant at the University of Kansas, now holds a similar position on the staff of the state entomologist, St. Anthony Park, Minn.

Mr. A. B. Gahan, M. S., formerly associate entomologist of the Maryland Agricultural Experiment Station, is now connected with the Bureau of Entomology, Washington, D. C.

Mr. Everett H. Cooper, who graduated in the class of 1913, Massachusetts Agricultural College, is teaching entomology at the College of Agriculture and Mechanic Arts, at Raleigh, N. C.

Prof. A. L. Quaintance of the Bureau of Entomology read a paper on "Insects Injurious to Nuts," at the meeting of the Northern Nut Growers' Association held at Washington, D. C., in November.

Mr. R. J. Fiske, a graduate of the Massachusetts Agricultural College, class of 1910, is now an inspector in the Department of Entomology of the Insular Government, Porto Rico.

Mr. J. A. Dew, formerly assistant in entomology at the Agricultural Experiment Station at Auburn, Ala., is now manager of the insecticide department of Van Antwerp's seed store, Mobile, Ala.

Doctor E. P. Felt gave the annual public address before the Entomological Society of America at Atlanta, Ga., Wednesday evening, December 31, on the subject of "Gall Insects."

Mr. George W. Peckham, author of several publications on solitary wasps, and spiders, died at his home in Milwaukee, Wis., January 11, after a brief illness, aged 68 years.

On November 28, 1913, Dr. W. J. Holland was elected an honorary member of the Royal Spanish Society of Natural Science, to fill the vacancy caused by the death of Lord Avebury.

President-Elect Theodore Wirth, of the Society of American Florists and Ornamental Horticulturists, has appointed Dr. W. E. Britton, New Haven, Conn., entomologist of the society for the year, 1914.

According to *Science*, Prof. F. V. Theobald, vice-principal and zoölogist of the Southeastern Agricultural College at Wye, Eng., has been awarded the Mary Kingsley medal of the Liverpool School of Tropical Medicine.

Mr. Frederick Maskew, chief deputy quarantine officer of California, has been sent to the Hawaiian Islands by the Federal Horticultural Board to study the Mediterranean fruit-fly situation there.

At Oberlin College Robert A. Budington has been promoted to a professorship, and Dr. S. P. Nichols to an assistant professorship in zoölogy. Dr. Charles G. Rodgers has also been newly appointed professor of zoölogy in the institution.

Messrs. C. L. Marlatt, W. D. Hunter, W. A. Orton, E. R. Sasscer, and Perley Spaulding, attended the section meeting of horticultural inspectors at Atlanta, Ga., January 1, 1914, as representatives of the Federal Horticultural Board.

The new biological building at Yale University is now completed. It houses the botanical and zoölogical departments, including entomology. It is a large and well appointed fireproof building of brown-stone.

Mr. Ralph W. Howe, a graduate of the Massachusetts Agricultural College, class of 1913, is now entomological assistant at Delta Laboratory, Tallulah, La., and is engaged in studying the cottonboll weevil.

Prof. A. L. Melander of the Washington College and Station, who is studying this year at Harvard University, lectured before the Brown University Chapter of Sigma *Xi* at Providence, R. I., November 24 on "The Control of Insect Pests."

It has been reported that the Federal Horticultural Board has asked Congress to appropriate $35,000.00 with which to prevent the Mediterranean fruit fly from becoming established in the United States.

The following were elected officers of the Washington Entomological Society at the annual meeting December 4, 1913: President, Dr. W. D. Hunter; first vice-president, A. N. Caudell; second vice-president, E. R. Sasscer; editor, W. D. Hunter; corresponding secretary-treasurer, S. A. Rohwer; additional members, of the executive committee, Dr. L. O. Howard, E. A. Schwarz, August Busck.

Colonel W. C. Gorgas, has been elected an honorary fellow of the Royal Sanitary Institute, London. Colonel Gorgas is chief sanitary officer of the Panama Canal Zone, and recently investigated the sanitary conditions of the port of Guayaquil, with the result that that city is to be cleaned and a proper sanitary system installed, at an approximate cost of $10,000,000.

Hugh Glasgow, Ph. D. (University of Illinois) has accepted an appointment as associate entomologist at the Geneva (N. Y.) Agricultural Experiment Station, in place of W. J. Schoene, resigned. He will devote his attention principally to the wood-boring insects attacking tree fruits, and to a study of the effects of insecticides on plant tissues.

From a note in *Science*, we learn that an address on "Collecting Insects in the Okefenoke Swamp" was given on December 2, 1913, before the New York Entomological Society by Prof. J. Chester Bradley of Cornell University, who was one of a

party to make biological explorations in this swamp in 1912, and who, in company with Prof. J. G. Needham, again visited the place in the summer of 1913. Okefenoke Swamp is situated in southeastern Georgia.

According to *Science*, "Capt. J. F. Siler of the Medical Corps of the United States Army and Mr. A. H. Jennings of the Bureau of Entomology have recently returned from the West Indies, where, in association with Dr. Louis W. Sambon of the London School of Tropical Medicine, they have been investigating pellagra and other tropical diseases in the interests of the Thompson-McFadden Pellagra Commission of the New York Post-Graduate Medical School and Hospital."

Mr. W. J. Schoene, formerly associate entomologist of the New York Agricultural Experiment Station at Geneva, N. Y., has been appointed state entomologist of Virginia and entomologist of the Agricultural Experiment Station at Blacksburg. He began his work there September 1, 1913. Mr. W. J. Price, acting state entomologist, has been retained as associate and will have charge of nursery and orchard inspection.

Dr. L. W. Sambon, who sailed from England in August, to investigate pellagra in the West Indies, returned to England in January, after visiting the United States. In the course of his trip he observed many cases of the disease, even where it was not previously known to exist. Dr. Sambon's investigations in Southern and Eastern Europe lead him to believe that pellagra is transmitted through the bite of some insect, probably a fly of the genus *Simulium*.

Mr. Arthur H. Rosenfeld, a foreign member of the American Association of Economic Entomologists, and entomologist and acting director of the Tucuman Agricultural Experiment Station in the Argentine Republic, has been named by the governor of Tucuman to be a member of the board to organize and administer the new university of Tucuman. Mr. Rosenfeld was also appointed a member of the rules committee of the University Board and a member of the Roosevelt reception committee on the occasion of ex-President Roosevelt's visit to that Province.

D. L. Van Dine resigned as entomologist of the experiment station of the Porto Rico Sugar Producers' Association at the end of the last fiscal year and returned to this country to re-enter the employ of the Bureau of Entomology at Washington. Mr. Van Dine has been assigned by Doctor Howard to make a study of malaria and the malaria-transmitting mosquitoes under the direction of Mr. W. D. Hunter. The work on malaria will relate particularly to the effect of malaria on agriculture and agricultural development in the South and to the bionomics of the species of mosquitoes involved. Mr. Van Dine's address is Bureau of Entomology, Department of Agriculture, Washington, D. C.

At the recent annual meeting of the Entomological Society of America, held at Atlanta, Ga., December 30 and 31, the following officers were elected: president, Dr. Philip P. Calvert; Philadelphia; first vice-president, Prof. James G. Needham, Ithaca, N. Y.; second vice-president, Dr. C. Gordon Hewitt, Ottawa, Can.; secretary-treasurer, Prof. Alexander D. MacGillivray, Urbana, Ill.; executive committee, Philip P. Calvert, James G. Needham, C. Gordon Hewitt, Alexander D. MacGillivray, Herbert Osborn, William M. Wheeler, Vernon L. Kellogg, Nathan Banks, E. P. Felt and J. M. Aldrich. Prof. T. D. A. Cockerell was reëlected a member of the committee on nomenclature, and Dr. C. Gordon Hewitt and Dr. William Barnes were elected fellows of the society.

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(*Continued.*)

Morning session, Thursday, January 1, 9.30 a. m.

PRESIDENT P. J. PARROTT: As the vice-presidents of the Association are not present I will ask Dr. W. E. Hinds to preside during the time the address is being discussed.

CHAIRMAN W. E. HINDS: The first business on the program is the discussion of the President's address, which was delivered yesterday.

MR. HERBERT OSBORN: I think all the members of the Association appreciate the President's address. I presume we found little in it to criticise or serve as a basis for prolonged discussion. I certainly appreciate what the President had to say and believe that this is a good time to express this appreciation.

MR. C. GORDON HEWITT: I would like to add my expression of appreciation for the President's address as representing another country which is closely allied to the United States in its economic progress. We in Canada owe very much to the early entomological work in the States, although our work began very early and our development has been along similar lines to those outlined in the address. The early efforts in Canada began in the Province of Ontario in the same way as the early efforts in the States began in Massachusetts. I think from that viewpoint the development or origin of economic work is very interesting, especially as our work began in connection with the agricultural work of the Province.

MR. T. J. HEADLEE: I want to thank the President for his paper. I think the information set forth should be of great help to the younger entomologists and I am glad that the President saw fit to take up this subject for his address.

Mr. George A. Dean: I wish to express my appreciation of the President's address and as one of the younger entomologists, it is certainly an inspiration to me to have reviewed the progress which has been made in entomology during the past fifty years and, particularly, the outline of progress made within the last few years. The work has now progressed to a point where we are reaching the farmer and he is securing direct benefit from it.

Mr. A. F. Conradi: I was interested in that part of the address where the speaker referred to the increased possibilities for research work since the passage of the Adams Act. In South Carolina this has resulted in preventing duplication of work and in increasing the force of men employed. The work has been centralized under one head so that it has become more efficient.

Chairman W. E. Hinds: If there are no other remarks I will retire and the regular program will be continued. Before doing so, however, I wish to congratulate our President on the address which he presented.

President P. J. Parrott: The first paper on the program will be presented by Mr. J. A. Dew, entitled, Some Properties of Various forms of Arsenate of Lead.

SOME PROPERTIES OF VARIOUS FORMS OF ARSENATE OF LEAD

J. A. Dew

Up to the present time little detailed investigation of insecticides has been conducted in the Southern States. Owing to the fact that there are large numbers of leaf-eating insects present the greater part of the year, arsenate of lead is by far the most widely used insecticide. Arsenate of lead was first used for poisoning leaf-eating insects in 1892, and during the past twenty years great manufacturing interests have developed to supply the present day demand. Naturally, with a large number of manufacturers in the field, there are several different forms of arsenate of lead on the market, most of which can be placed in two classes, viz: first, acid, meta, or bi-plumbic ($PbHAsO_4$) and second, neutral, ortho, or tri-plumbic ($Pb_3(AsO_4)_2$); but recently there has appeared what is known as basic arsenate of lead. This last-mentioned form contains an excess of the base and was put on the market for special use in humid areas where the other forms caused injury.

The present paper is a preliminary report of the work done by the writer during the past year to determine just what forms of arsenate of lead are the most effective and what characteristics give the insec-

ticide its value. The most important point to be determined was whether or not the killing power of arsenates of lead varied directly with the percentage of As_2O_5. In order to get data on foliage effect, time of application, etc., at the same time determining the above points, a peach orchard was selected which was known to be infested by the plum curculio (*Conotrachelus nenuphar*). The trees selected were all of the Mayflower variety, five years old, and stood in a compact block, all the trees being equally distant from wooded areas. The spraying was done by the writer with a barrel pump, mist nozzle and under a pressure of 110 pounds. The first application was made just as the shucks began to slip, followed in thirteen days by the second. Besides the arsenate of lead the second spray contained self-boiled lime-sulfur wash (8-8-50). A period of drouth extended over the entire time covered by the experiment, April 12—June 1. During April the precipitation was 1.4 inches (1.9 less than normal) and during May was .45 inches (3.4 less than normal). There were no washing rains, the total of 1.8 inches falling in showers on eight different days. The mean temperature during this time was 63.8°F.

All the data presented below is taken from daily records made in the orchard which include the record of the daily fall of fruit as well as of those picked and placed on the market June 1. The experiments were divided into two series. The first included those plots sprayed with a specific number of pounds, calculated on a dry basis of the different forms of arsenate of lead, and the second included those sprayed with a specific number of units of As_2O_5 derived from these same forms. The plots were made up of from eight to twelve trees and two from each plot were used as count trees. Below is given a table containing the data obtained from the first series.

TABLE I

Plot No.	Amt. dry Ars. lead	Form of Ars. lead	Units of As_2O_5	Percentage wormy	No peaches in count
1	1 lb.	basic	19.99	11.8	1,069
2	1 lb.	neutral	25.60	10.1	876
3	1 lb.	acid	33.38	5.4	759
16	No spray	—check		37.4	646

Examination of these results indicates that the killing power of the arsenate of lead varies directly with the percentage of As_2O_5 that it contains.

The second series of the experiments was based upon the application of specific units of As_2O_5 derived from different forms of arsenate of lead and the results are as follows:

TABLE II

Plot No.	Amt. dry Ars. lead	Form of Ars. lead	Units of As_2O_5	Percentage wormy	No. peaches in count
3	1 lb.	acid	33.38	5.4	759
10	1 lb.	acid	33.38	4.9	865
12	1 lb.	acid	33.38	6.8	581
7	1½ lbs.	neutral	37.00	4.3	761
13	1½ lbs.	neutral	37.00	6.6	495
15	1½ lbs.	neutral	37.00	5.0	694
16	No spray	—check		37.4	646

NOTE.—Arsenate of lead as found on the market was used. As_2O_5 calculated on dry basis.

From the above table it is readily seen that when derived from the neutral or acid arsenate of lead, 33 units of As_2O_5 gave practically the same control as 37 units and that an excess of the units used above 33, therefore, does not give a corresponding decrease in the percentage of wormy fruit. This indicates also that the percentage of As_2O_5 and not the form, determines the killing power.

A different grouping of the data already given with the addition of the facts obtained from a plot (No. 4) on which 3¼ pounds of basic arsenate of lead was used will bring our two other points, viz.: basic arsenate of lead did not become available under the existing climatic conditions in sufficient degree to give good control, and second, an excessive increase of the number of units above 33 does not give a corresponding decrease in the percentage wormy.

TABLE III

Plot No.	Amt. dry Ars. lead	Form of Ars. lead	Units of As_2O_5	Percentage wormy	No. peaches in count
3	1 lb.	acid	33.38	5.4	759
10	1 lb.	acid	33.38	4.9	865
12	1 lb.	acid	33.38	6.8	581
13	1½ lbs.	neutral	37.00	6.6	495
7	1½ lbs.	neutral	37.00	4.3	761
8	1½ lbs.	acid	49.00	3.8	728
4	3¼ lbs.	basic	66:00	10.1	865
16	No spray	—check		37.4	646

The table above combined with the two previously given indicates the following facts:

1. The lowest number of units of As_2O_5 necessary to give an effective control of the plum curculio is 33 (Plots 13, 7, 8).

2. One pound of an acid arsenate of lead (33% arsenic oxide) has more killing power than a pound of neutral arsenate of lead (25%—27% arsenic oxide), and each more killing power than 1 pound of basic arsenate of lead (20 % arsenic oxide) (Plots 1, 2, 3).

3. Under similar climatic conditions, the killing power of an acid or a neutral arsenate of lead depends directly upon the percentage of As_2O_5 that it contains.

4. Basic arsenate of lead, under the climatic conditions prevailing while the experiment was being conducted, became too slowly available to give good results even when double quantities were used. In fact there was little difference between the effect of 1 pound and 3¼ pounds. (Plots 1 and 4).

During this series of experiments, in fact within three days after the beginning of the examinations, two classes of fallen fruits were distinguished, viz.: those normally shed (peaches shed naturally by reason of overproduction, retaining the stem) and, second, those abnormally shed (peaches shed by reason of some injury, the stem remaining on the tree). After careful examination of the abnormally shed fruits they were divided into two distinct groups, viz.: those containing a feeding or egg puncture made by curculios or other insects, and second, those showing no insect injury but having a slight shriveled area at the base, caused presumably by the effect of spray solution which had collected at that point.

A careful daily record was kept of these classes of fallen fruits both from the sprayed and unsprayed plots. That the abnormal shedding which could not be attributed to insect injury was due to the effect of arsenicals is indicated by the fact that the unsprayed check plots gave less than 2 per cent of this class of fruits. However, the figures given below show the results of these examinations.

TABLE IV

	No. peaches in count	No. peaches abnormally shed	No. punctd. Shed by insects	Not punctd. No cause assigned	Percentage	
					Insect	No cause
Sprayed....	10,181	3,208	2,224	984	69.3	30.7
Unsprayed .	6,331	5.113	5,019	94	98.1	1.9

NOTE.—No sprayed plots showed burning of foliage to any large extent although sprayed trees shed a few more leaves than those not sprayed.

Believing this shedding to be caused by the arsenicals contained in the spray the next points to be determined were: What form of arsenate of lead causes the most shedding and does the shedding vary directly with the units of As_2O_5? The data accumulated on this point is given below.

TABLE V

Plots	Units As_2O_5	Abnormal shed	Form of Ars. lead	No. shed. No cause	Percentage shed. No cause
3, 10, 12 & C	33	555	acid	238	42.8
7, 13, 15 & B	37	821	neutral	267	32.5
Checks 16 & D		6,331	....	94	1.9

From these figures it is clearly seen that the plots sprayed with acid arsenate of lead lost more of the unclassified peaches than did those where a neutral product was used, although on the neutral plots more units of As_2O_5 were used.

In the next table is given the relative shedding on three plots sprayed with 1 pound of basic, neutral and acid arsenates of lead.

TABLE VI

Plots	Units As_2O_5	Form of Ars. lead	Abnormal shed	No. shed. No cause	Percentage shed. No cause
1	20	basic	219	78	35.9
2	27	neutral	187	91	48.5
3	33	acid	96	45	46.8
16–D			6,331	94	1.9

From this comparison it is quite clear that there is no direct ratio between the units of As_2O_5 and the percentage shed. This is further evident by the following:

TABLE VII

Plots	Units As_2O_5	Form of Ars. lead	Abnormal shed	Shed. No cause assigned	Percentage shed. No cause assigned
1	20	basic	219	78	35.9
4	65	basic	190	75	39.4

From the four tables given in this section of the paper, the following facts are indicated:

1. That when used in accordance with the spraying practices of the present day, all trees sprayed with the different forms of arsenate of lead used in these experiments, shed a comparatively large number of fruits showing no insect injury.

Constant characteristics of these fruits are that the stems remain on the tree and the fruits show a slight shriveling at the base.

2. That the number of these shed fruits varies with the form of arsenate of lead used and that the acid forms causes the greater percentage of loss.

3. That this shedding does not vary directly with the units of As_2O_5 used, but apparently depend more on the form of arsenate of lead.

Mr. J. A. Dew: I wish to say that the suggestions in this paper are not conclusions, but some points came up while the work was being conducted and I thought it might be interesting to the members of the Association to bring them forward at this time. The work was

originally intended for a local experiment but is now an Adams project under Doctor Hinds, Auburn, Ala., and this paper is presented with his permission.

MR. W. E. HINDS: I wish to bring out one point which I think is of interest. In the applications that have been made we found indications of a shedding due to the direct arsenical effects of the spray. Some of the fruit that was shed from treated trees had certain characteristics by which it could be distinguished from fruit shed from untreated trees. The question has been brought up in connection with these experiments as to the extent of this shedding due to arsenical application. The percentage varies considerably when the neutral and acid forms of arsenate of lead are used. As far as I know this point has not been considered heretofore. I would suggest at this time to those who have arsenate spraying projects under way that they see whether any way could be found to offset the shedding of unpunctured fruit.

MR. W. M. SCOTT: Was there any difference noted as to the effect of different forms of arsenate of lead on the foliage?

MR. W. E. HINDS: We had practically no injury. There were a few burned areas but not enough to be of economic importance.

PRESIDENT P. J. PARROTT: Mr. A. L. Melander will present the next paper entitled, "Can Insects become Immune to Spraying?"

CAN INSECTS BECOME RESISTANT TO SPRAYS?[1]

By A. L. MELANDER, *Entomologist, Washington Agricultural Experiment Station*

There is a prevalent feeling in some districts that sulphur-lime is less efficient now than formerly in controlling San José scale, or orchard aphides, or the brown mite. This has been largely ascribed to the general adoption of the factory-made clear solution which is popularly regarded as subject to a mysterious adulteration.

There seems to be no question but that some years and in some places sulphur-lime is a rapidly acting insecticide. In Piper's elaborate experiment at Wawawai, Washington, in 1902, he repeatedly found all the scales dead a week after the application. The same is true of some Wenatchee scales I examined two years ago. At the same time that these Wenatchee scales were counted, specimens from Clarkston, Washington, sprayed two weeks before, showed 90 per cent alive. Even with 26° sulphur-lime, ten times stronger than a normal application, 74 per cent of the scales were still alive.

In the experiment of 1902 Piper discovered that sulphur-lime was

[1] Contribution from the Entomological Laboratory of the Bussey Institution, Harvard University, No. 75.

equally effective whether applied one pound of sulphur to three gallons, or one pound to six gallons. I noted the same in some tests at Clarkston in 1908, but discovered that here and there on certain branches were individuals that were still alive a month after spraying, although as well covered by the spray as the others. This experiment was repeated in 1910 at Walla Walla, Washington, with the same results, except that a considerable number of the scales, averaging more than 10 per cent, was still alive.

For several years the San José scale has been increasingly prevalent in the Clarkston Valley. The growers have erected a local sulphur-lime factory in the effort to control faulty preparation of the spray; they have drenched their trees by power spraying in the endeavor to overcome faulty application, and yet the scale has uncontrollably spread. Some branches I examined in 1912, that had been given three applications, at intervals of about two weeks, using a hot sulphur-lime of the 30:40:100 formula, showed 50 per cent. of the scales still alive under the crust of dried spray.

This led us last spring at the Washington Station to try identical solutions in a number of localities, and then to make bi-weekly counts of the proportion of living and dead scales,—an experiment we were able to carry on through the help of the Adams Fund. Clarkston, Walla Walla, Kennewick, Prosser, Sunnyside, North Yakima and Wenatchee were the localities selected, comprising an air-line circuit of four hundred miles, and at each place materials from the same stock were used. In the course of the bi-weekly visits made to these places upwards of 350,000 scales were individually examined under the binocular microscopes, by my assistant, M. A. Yothers and myself.

PERCENTAGE OF LIVING SCALES

	No. Yakima				Sunnyside				Clarkston			
	When sprayed	2 weeks	4 weeks	6 weeks	When sprayed	2 weeks	4 weeks	6 weeks	When sprayed	2 weeks	4 weeks	6 weeks
1. Sulphur-lime 5°........	92	57	30	0	95	60	6	0	95	90	77	8
2. Sulphur-lime 3°........	92	80	51	0	95	78	3	0.5	95	92	81	13
3. Sulphur-lime 2°........	92	75	40	0.5	95	76	4	0	95	90	76	17
4. Sulphur-lime, 1:½:5.....	92	88	35	0.1	95	93	2	0.2	95	93	75	4
5. Sulphur-lime, 1:2:5.....	92	50	22	0.2	95	58	4	0	95	77	52	8
6. Spramulsion...........	92	44	2	2	95	50	7	2.4	95	70	40	12
7. Orchard Brand Oil Spray	92	6	0	0	95	13	0	0	95	4	1	0
8. Fuel oil emulsion.......	92	60	0	0	95	91	0	0	95	62	0	0

For the sake of brevity the accompanying table shows the results obtained at but three of the places, North Yakima, Sunnyside and True's orchard, Clarkston, selected because the conditions for the

experiment were ideal in each of these cases. The trees were vigorous, the scales abundant, the applications thorough and bad weather did not interfere. The figures show the proportion of scales rated as alive at the successive bi-weekly counts. The first experiment represents 5° factory-made sulphur-lime, approximating one pound of sulphur to three gallons. The second, 3° sulphur-lime, or one pound to five gallons, the third 2°, or one pound to seven gallons. Then follow two sulphur-limes prepared just before the application, experiment four, 3°, corresponding to the second experiment, and number five, with the same amount of sulphur but with four times the chemical requirement of lime. The sixth test gives a carbolated emulsion, called Spramulsion, prepared on the Pacific Coast. The last two represent oil sprays made with a fish oil emulsifier: Thomsen's Orchard Brand and a fuel oil emulsified during the tests.

It will be observed that the normal action of the sulphur-lime is continuous, producing complete destruction of the scale in a little more than a month's time. In the Clarkston experiment, however, from 4 to 13 per cent, or more, of the scales were alive six weeks after spraying, at which time they had begun their spring growth and were probably but little susceptible to whatever weathered sulphur-lime remained.

Attention may be called to the similarity of the results obtained with the last two oil sprays at all three places, showing that Clarkston scales have no resistance to these sprays, and to the similarity of the action of sulphur-lime used at North Yakima and Sunnyside, as compared with Clarkston. It is evident from these figures that the San José scale at Clarkston manifests a decided resistance to the action of sulphur-lime.

Although sulphur-lime has come to be regarded quite as a panacea, because of its destructive action on fungi, lichens, insect eggs, scales, etc., yet it is specifically a scalecide, and particularly is used against the San José scale during its hibernating condition. Other scales are less susceptible, the naked Lecaniums not at all, and thick shelled or active insects emerge quite unharmed from a bath of sulphur-lime. Even the San José scale shows a variable susceptibility, for during the growing period sulphur-lime has proved to be much less effective. Furthermore, there is a sex-difference, for among the resistant individuals escaping the action of the spray, the majority are males. Sulphur-lime is not a universal poison; it does not assure certain destruction of all insects; and there is thus a chance for an immunity to manifest itself in increasing degree as the insects become acclimatized.

The physiological effect of sulphur-lime is believed to be due to

a chemical reduction of the insect, an action that is vigorous at first but after a few weeks or days gives place to a chemical deposit of sulphur. The effects are thus not altogether immediate, but prolonged, and the reactions grow weaker day by day. That the San José scale is able to resist the first shock of deoxygenation is evident from the abundance of living scales for several weeks after the application.

It is a difficult matter to determine just when a scale insect dies. A killed scale becomes dry in a few days, during which time its protoplasm changes from a pale yellow juicy condition, through a viscous sirupy stage, to a darker yellow oily meal. This reaction is not reversible, and thus differs from the first effects of dessication, from which insects may be revived. In making counts of the scales we rated as dead all insects that showed gelation of the protoplasm when crushed under the microscope.

That the San José scale should become acclimatized to a sulphur-lime environment is not altogether a strange thing. There are organisms living in sulphur springs, in thermal springs, in hypertonic salt and alkaline lakes, and even in petroleum wells,—all of them environments fatal to normal forms. An example of such abnormal species in the making can be readily observed in an estuarial tension life-zone, where the salt water forms are invading the fresh water region, and the fresh water species are becoming adapted to the recurring tides.

One of the strangest instances of acclimation is the case of arsenic eaters. By consuming repeated small amounts of arsenic the body becomes immune to many times the normal lethal dose. When arsenic spraying for leaf-eating insects is imperfectly done it is quite possible for the insects to get daily homeopathic doses of arsenic and to become progressively resistant. Indeed, Mr. R. W. Glaser of the Bussey Institution, has experimentally verified this supposition in his work with the gipsy moth. By successively administering more and more spray, he tells me that he has succeeded in rearing a series of moths from larvæ that finally were feeding on heavy dosages of arsenate of lead. Indeed, these larvæ were especially hardy, and developed as strong an immunity to disease as they did to the arsenic. This may be the underlying reason why spraying for half-grown caterpillars and grasshoppers is usually so ineffective.

While immunity to arsenic may be a greater factor in the control of insects than we at present know, yet it is an adaptation of the individual only. We do not know that such an acquired immunity affects subsequent generations, although it would not be inconceivable that arsenic antibodies are passed on by the mother into the egg to give the offspring some initial immunity.

The resistance of the San José scale, however, is of a different kind. Spraying affects every tenth generation or so, and it is quite unlikely that an acquired immunity should make its effects felt over so long a period. Sulphur-lime spraying in the orchard districts is compulsory by law and so practically every scale is subjected to its action. We have often noted an individual scale, or a group of scales, probably brothers and sisters, still alive in the midst of a mass of dead insects. Such vigorous individuals have been just as thoroughly wet with the sulphur-lime as their neighbors, yet have escaped its action. The sporadic occurrence of naturally immune individual scales finds a parallel in recent work on heredity of protozoa and bacteria. Mutants less or not susceptible to certain toxins have been repeatedly found in cultures and from them have been produced immune strains. Similarly, disease-resistant wheat has been produced through Mendelian segregation, the new strain acting as a pure recessive.

The data at present at hand do not permit us to determine whether resistance and susceptibility are differences of degree and not of kind, or whether they behave as allelomorphs. That the mortality curve of the Clarkston scales is less steeply inclined from the beginning might indicate a partial immunity already possessed by nearly all the scales, but which is pronounced enough to be an absolute immunity only in a relative few. Such a view is especially interesting when we recall the reported rapid action of sulphur-lime a few years ago.

What is the economic importance of the appearance in a locality of a resistant strain of the San José scale? An alarmist might say that a few such scales would soon result in a totally immune insect, brought about by annual spraying. But viewed from a Mendelian standpoint, the consequences are less direful. If only the resistant individuals survived to reproduce then a pure line might result after repeated sprayings. But always there are some scales missed by the spraying, and these, during the ten generations between sprayings, will produce a population in part, at least, non-resistant. If resistance were a dominant characteristic there would already be a larger proportion of immune individuals than the data show. If it is recessive the crossing with scales missed by the spray would, by the end of each year, produce a majority of susceptible individuals. Thus we may make the strange assertion that the more faulty the spraying this year the easier it will be to control the scale the next year.

Practically, a change from sulphur-lime to an oil spray is all that is necessary for effectual control. However, even in the case of the oils we have noted a very few individuals that have manifested a remarkable tenacity of life. Should these result in a resistant strain sometime in the future it would be necessary to use both insecticides,

and then if the same individuals were doubly resistant we might have to introduce a weak strain of the the San José scale to cross with the immunes and thus return to the normal susceptible population.

President P. J. Parrott: This is a very unique paper and ought to provoke considerable discussion.

Question: Are the records on the chart the result of a single year's experiment or combined results of several years?

Mr. A. L. Melander: The curves were built up from last year's work at three different places.

Question: Can you tell us why the Clarkston results were not as good as the others?

Mr. A. L. Melander: I tried to explain in the paper that I believed that the Clarkston scales possessed a hereditary resistance to the lime-sulphur spray. This may possibly be due to the fact that they have been subjected to this spray longer than any other place, for the lime-sulphur has been used longer in that valley in Washington than anywhere else in the northwestern part of the country.

Mr. W. C. O'Kane: I was interested in what the speaker had to say in regard to the immunity of caterpillars to arsenic. I would like to know whether, after the first or second spraying, the caterpillars were increasing in size, and resistance, and were consuming much more than a dose which would ordinarily kill them?

Mr. A. L. Melander: He told me that they were feeding and consuming many times as much poison as should ordinarily kill them.

President P. J. Parrott: Can Doctor Wheeler give us any figures on the experiments which were conducted by Mr. Glaser?

Mr. W. M. Wheeler: Mr. Glaser did not advise me in regard to the results of these experiments. I think they were taken up in connection with other work.

Mr. E. P. Felt: I would like to ask Mr. Burgess if it is not a fact that when the gipsy moth caterpillar becomes nearly grown it is very difficult to destroy it with poison.

Mr. A. F. Burgess: Yes, that is true. If spraying is done when gipsy moth caterpillars are nearly full-grown it is very difficult to kill them. I think Mr. Glaser must have secured these results in connection with other experiments which he was carrying on.

President P. J. Parrott: In using the lime-sulphur wash we have found from past experience that spraying may not kill the parent, although the treatment is destructive to the progeny. Has this been your experience?

Mr. A. L. Melander: Considering the results from a chemical

standpoint the effect is weaker day by day. In the cases mentioned the lime-suphur wash was effective within a week after its application.

PRESIDENT P. J. PARROTT: We have conducted some comparative experiments in New York with the polysulphides of barium, calcium, sodium and potassium. The percentage of scales killed by the different compounds ranged from about 94 to 100 per cent. The calcium and barium preparations were uniformly more effective than the other mixtures. With all of the polysulphides there was some breeding, which was more noticeable on the trees sprayed with the sodium and potassium mixtures. This difference in effectiveness we attributed to the greater solubilities of the latter compounds.

Question: What results did you have with the polysulphide of calcium?

PRESIDENT P. J. PARROTT: The barium polysulphide was the most efficient preparation, while calcium polysulphide ranked as a close second in effectiveness.

A member: I have noticed that we cannot get good results with lime-sulphur wash after the 1st of April, that is, after the trees begin to grow actively. For some unknown reason the scales are not killed after this time.

PRESIDENT P. J. PARROTT: The next paper will be read by Dr. E. P. Felt on "The Reactions of Sugar Maples to Miscible Oils."

THE REACTION OF SUGAR MAPLES TO MISCIBLE OILS

By E. P. FELT, *Albany, N. Y.*

(Withdrawn for publication elsewhere.)

MR. GLENN W. HERRICK: Have you noticed any effect as to the time of spraying and have you any data on the effect of miscible oils on other trees than maples?

MR. E. P. FELT: Most of the injury we observed in certain cases followed spraying in the fall. We have studied several apple orchards where a serious condition developed, the damage being closely restricted to trees or even parts of trees which had been treated with a miscible oil.

MR. Z. P. METCALF: Our experimental results have shown that miscible oils are not the only thing that cause injury. A few years ago at Charlotte, N. C., I found three trees in three widely separated localities showing practically the same injury to the lower branches. One was a sugar maple which was not infested by insects and had not been sprayed. Another a silver maple which had been sprayed the previous

year with lime-sulphur wash and the third was sprayed the same year with soluble oil on the lower branches. The lower branches of all three showed practically the same effect, as near as I can judge, as those mentioned by Doctor Felt. It was, however, a very unusual condition. I would like to ask Doctor Felt if he has found this condition in trees that have not been sprayed with miscible oil.

MR. E. P. FELT: We have observed trees in apparently the same condition, though in our own experience a close examination has shown differences from the symptoms which we have noted as following the application of miscible oils.

MR. W. M. SCOTT: As I understand it this injury was confined to sugar maples; other maples were not affected by this spraying?

MR. E. P. FELT: My observations in this particular case related to the sugar maple and the ordinary soft or white maple. The latter seem to be fairly tolerant, the sugar maple quite susceptible to injury.

PRESIDENT P. J. PARROTT: The next paper will be presented by Mr. L. M. Peairs, entitled, "The Relation of Temperature to Insect Development."

THE RELATION OF TEMPERATURE TO INSECT DEVELOPMENT

By L. M. PEAIRS, *Morgantown, W. Va.*

At meetings of the American Association of Economic Entomologists held in Chicago in 1907–1908 and in Boston in 1909, Director E. D. Sanderson, then of the New Hampshire Experiment Station, presented papers dealing with the relation of heat to the various activities of insects, notably with the effect of heat on development, distribution and hibernation of insects.[1] The papers were based on an accumulation of data taken by him at the New Hampshire Station and included some results from other sources. The last paper had also a résumé of the existing theories of the effect of heat upon development and showed some of the weaknesses of those theories, at the same time advancing theories of his own on the subject. These theories, as worked out by the writer from the data of Director Sanderson with additions from other sources, have proved to be remarkably sound. The theory offered for the proper method of computing accumulated temperatures (Jour. Ec. Ent., Vol. III, pp. 136–137) is shown in the present paper to be correct. Fig. 10–15 and the accompanying discussion well illustrates this point.

[1] Journal of Economic Entomology, Vol. I, pp. 56–65, 245–262, and Vol. III, pp. 113–140.

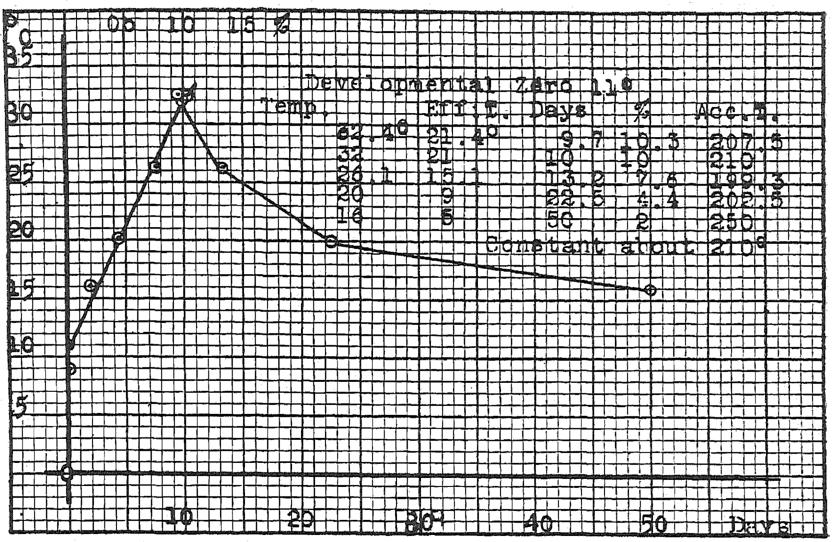

Fig. 10. Pupæ of *Malacosoma americana*. Drawn from data by Sanderson.

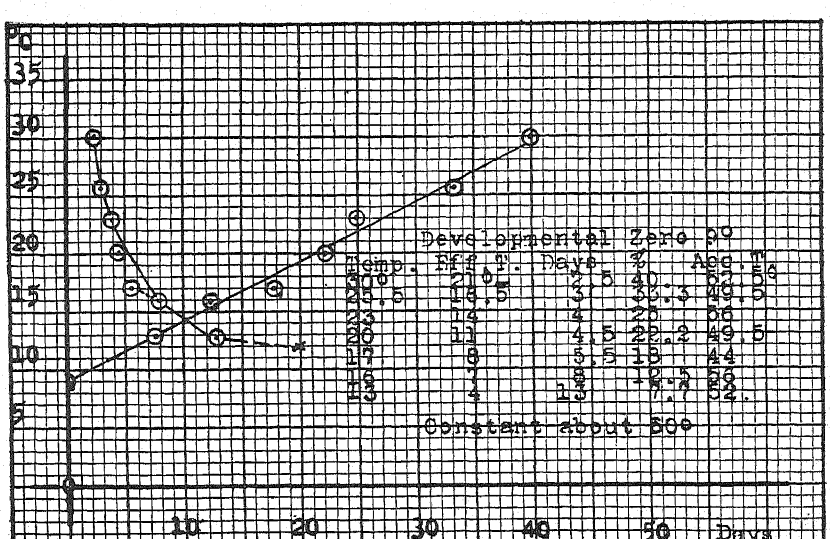

Fig. 11. Eggs of *Heliothis obsoleta*. Adapted from Sanderson, Jour. Ec. Ent., Vol. III, p. 125.

The aim of the present writer has been then, to develop the theories of Director Sanderson and prove or disprove them; to formulate such laws as might be found to govern the action of temperature conditions on insect development, and by so doing, to place the study of temperature in this connection on a more definite basis than it has been heretofore.

This work has been done at the West Virginia Experiment Station under the direction of Director Sanderson, and the full statement of the results, as well as the data upon which they are based, is soon to appear as a bulletin of the New Hampshire Station where the work was started and most of the data taken.

The study has seemed to prove the following points and we would therefore propose them as tentative laws:

1. The rate or velocity of insect development is affected by temperature, and, other factors being constant, this rate increases in direct proportion to the increase in temperature, *within the normal limits of development.*

2. The curve expressing the increase in rate of development is a true hyperbole.

3. The Developmental Zero or what has been styled the "Critical point," is at or near the point where the reciprocal curve for the time factor intersects the temperature axis.

4. The thermal constant for an insect or any stage of an insect is the constant for the developmental curve for such insect or stage.

5. The effective temperature for conditions of variable temperature, *i. e.*, the ordinary daily variations, is higher than the mean for the period. (This point is not supported by any evidence in the present paper but there is little doubt in the mind of the writer that it will be found to be correct.)

The first law is not new but has been generally recognized for many years. It therefore needs no discussion. The second one has not, so far as we know, been definitely stated in any published paper. The proof is the shape of the curves plotted from experimental data and the shape of the reciprocals plotted from these curves. One of the properties of an hyperbole is that the reciprocals plot to a straight line. Another is, that the product of the two factors establishing any point on the curve is equal to the product of the factors establishing any other point on the curve; in other words, it is a constant. The shape of the reciprocals from the experimental curves is graphically shown in the figures. On the figures is shown the accumulated temperatures for the different points establishing the curves. These theoretically, should be constant. Their near approach to the constant, under experimental conditions, is additional proof as to the nature of the curve.

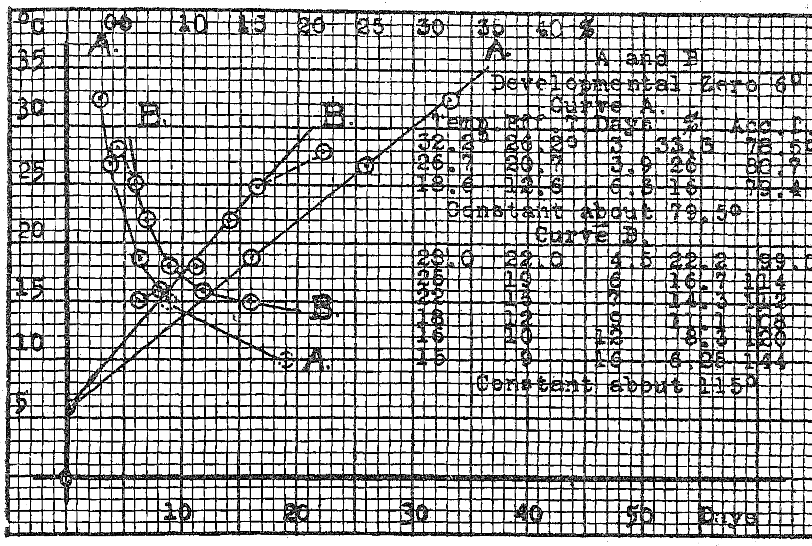

Fig. 12. A. Eggs of *L. decemlineata*. Drawn from data by Sanderson. B. Eggs of *C. pomonella*. Drawn from data by Hammar, Bu. of Ent., Bull. 115, Pt. I.

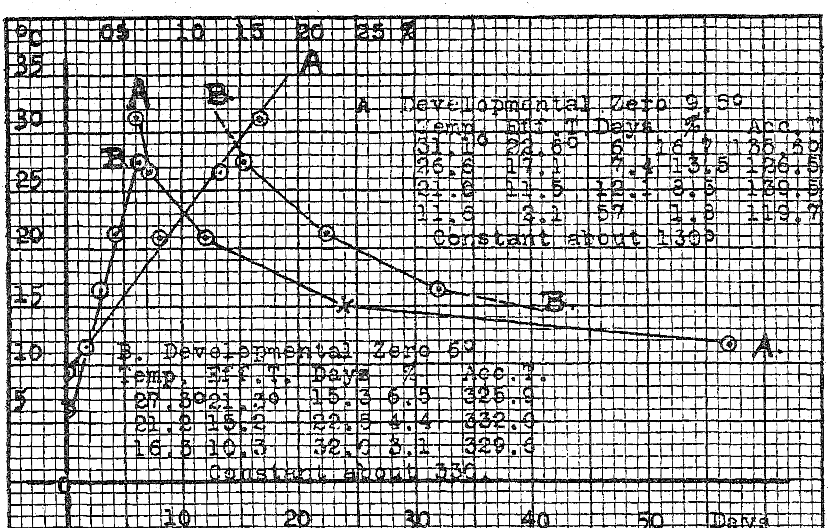

Fig. 13. A. Eggs of *Tenebrio molitor*. B. Larvæ of *Euproctis chrysorrhoea*. Drawn from data by Sanderson.

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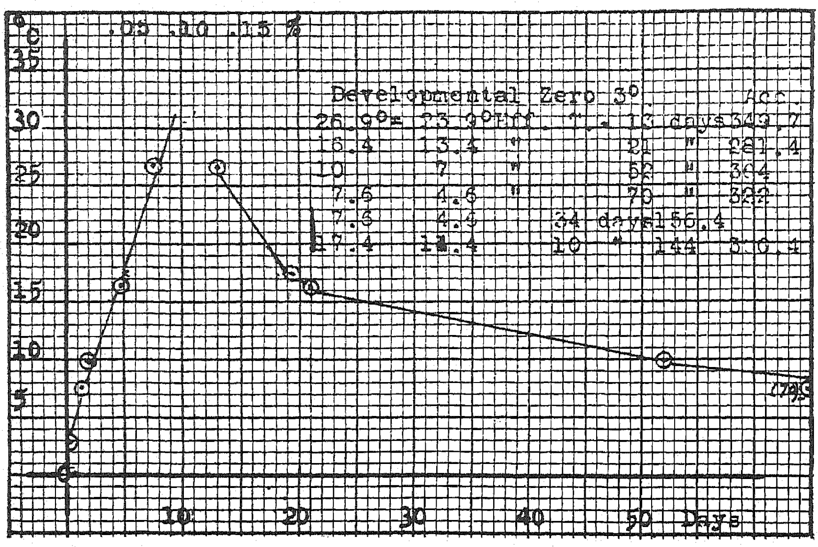

Fig. 14. Eggs of *Porthetria dispar*, after cold storage conditions. Drawn from data by Sanderson.

NOTE.—The co-efficient for a day at 7.6° is .014, at 17.4° it is .05, the value of a day at 17.4° being 3.6 times that of a day at 7.6°.

.014 x 34 days gives .486
.05 x 10 days gives .50

Total .986 as opposed to the theoretical 1.00. Also: 10 days at 17.4° equal 10 x 3.6 or 36 days at 7.6°. Adding this to our actual 34 days at this temperatute we have a theoretical 70 days as opposed to 70 days for the lot kept in 7.6° until emergence. Conversely, 34 days at 7.6° equal 34 divided by 3.6 or 9.5 days. Added to the 10 days actually spent in the 17.4° temperature we have a theoretical period of 19.5° as opposed to an actual experimental period of 21 days for a temperature of 16.4°.

Law No. 3 is based to a certain extent on theory. We know that the point in question is, and by definition must be, the zero for the curve. That it is actually, also, the zero for the development of the insect would seem theoretically probable and the evidence all points to the truth of this assumption. For instance, we have insects completing their development at temperatures but one or two degrees above this temperature, while others within the same distance of the point, but below it, never develop.

Law No. 4 depends to a considerable extent upon the ones preceding. In computing the accumulated temperatures it is necessary to use, not the actual temperatures or number of degrees above an arbitrary zero as on the Centigrade or Fahrenheit scales, but the *effective* temperatures or numbers of degrees above the calculated developmental zero. It will be seen that these accumulations, as stated above, in curves based on experimental data, approach a con-

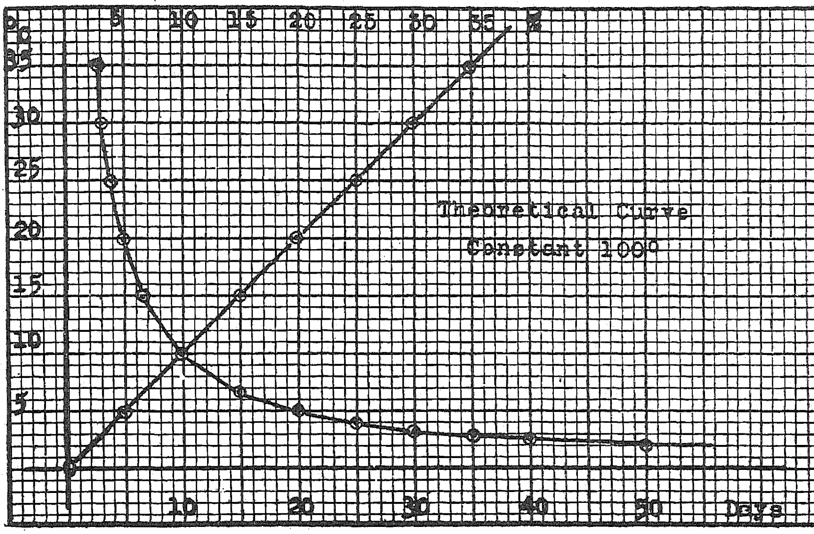

Fig. 15. A true mathematical hyperbole, showing the relation of the reciprocal to the curve.

stant in a manner highly satisfactory and seem to prove not only that there is a thermal constant, but that it is the constant for the developmental curve.

The fifth law proposed is based only partly on the same data as the others and is greatly strengthened by the results of later experiments, the reports from which are not yet ready for publication.

A study of the curves themselves and the data upon which they are based will help to an understanding of the conclusions advanced. The figures show only a very few of the typical ones but should serve to throw light on the methods of calculation employed.

If the above conclusions, however faulty they may be and however much the laws may need revision, help to place the study of temperature and its effect on the activities of insects on a definite basis, the writer feels that their presentation here will have been justified.

Question: I had always supposed that there was a certain point of optium temperature for development and I do not understand how this idea conforms to the statements given in this paper. It would seem that the higher the temperature the more rapid the development without any limit. How can we adapt this idea to the figure that the speaker has exhibited?

Mr. L. M. Peairs: You will notice that I stated in my paper that the development increases within normal limits of development, and we have not worked out the top of the curve.

MR. W. C. O'KANE: In examining the curve I see that some are computed from as few as three or four points. I want to ask Mr. Peairs if he feels that he had absolute control over moisture and light. It seems to me that where you are computing a curve and you have only three or fours points, that unless you have absolute control over moisture and light you may be misled.

MR. L. M. PEAIRS: The control was not absolute of course. At the present time I am working with different species of flies and have incubators running where I am controlling both light and moisture and while I did not use any of this data in the paper presented, the information which is being secured seems to bear out the conclusions which have just been given.

MR. C. GORDON HEWITT: I presume the same type of food has been used throughout the experiment. The rate of development is considerably influenced by the nature of the food as well as the factors of temperature and moisture. The chief interest in this work lies in the fact of the use we may be able to make of extremes in temperature. The sooner we get these facts, the sooner we will be able to secure value from experimental data of this sort.

MR. V. E. SHELFORD: I would like to ask what precaution was taken in ventilating the cages?

MR. L. M. PEAIRS: The ventilation was measured by pumps. In answer to Doctor Hewitt's question I will state that most of the insects under observation were either in the egg or pupal stages so that no food was required.

MR. A. F. CONRADI: The work in South Carolina has been directed towards securing moisture control. We have an elaborate machine by which we have tried to determine the moisture and the amount of air passing through the rooms. Heredity also comes in, as an important factor and should be given consideration as well as moisture and temperature.

MR. C. GORDON HEWITT: We should take into consideration the hereditary disposition of the different stages.

MR. W. C. O'KANE: If the transformations are computable on a mathematical or geometrical basis, how are we going to account for the delayed development of pupæ under natural conditions? In some places we have development occurring with some individuals within a few weeks after they are laid, while other eggs under the same conditions do not develop until the following summer.

MR. L. M. PEAIRS: There are certain phenomena that actually occur in variance with our theories as presented. So far we have been unable to explain them on any grounds other than heredity, and heredity is a factor that we can not control in experimental work.

President P. J. Parrott: We observe this phenomenon with the cabbage maggot. It will be necessary to bring this discussion to a close, and I will call for the next paper by Prof. W. C. O'Kane on "Further Experience with an Insectary."

FURTHER EXPERIENCE WITH AN INSECTARY

W. C. O'Kane, *Durham, N. H.*

Five years ago we built an insectary at the New Hampshire Experiment Station. The idea was to provide a permanent structure which would afford natural conditions for life history work.

The building was made 13 x 24 feet At one end is a wood structure 6 x 13 feet. This has solid walls and roof, two ordinary glass windows and an entrance door. From it another door leads to the open work-room.

The latter is 13 x 18 feet. It was made with removable screen sides set in a framework that could be taken down by removing bolts and screws. The roof of this work-room was of canvas and was made double, allowing air space between.

The entire structure is carried on a concrete wall rising 18 inches above the ground. In the small enclosed room a concrete floor was laid. The larger open room was provided with a cement floor down the middle. On one side of this are six concrete pits and on the other a strip of soil 2 feet wide. This strip of soil as well as the dirt in the pits is continuous with the ground beneath. A full description of the building, and photographs of it, will be found in the Journal of Economic Entomology, Vol. 2, page 389.

Experience with this insectary has led naturally to the proof of some advantages and the discovery of some disadvantages. The former are as follows:

The large, open work-room is an excellent place for carrying on some kinds of experiments through the summer season, especially such as require the use of small breeding cages. The temperature is the normal of the air. Humidity is normal. The bins and the earth strip provide fairly acceptable soil conditions, but not a normal amount of moisture in the surface layer.

In winter the frame work, screens and canvas top are removed. The open structure has then been used for general storage of hibernating material. The earth in the bins and in the strip has been used for earth storage. The closed section has served for storage under shelter.

The disadvantages discovered have been as follows:

For summer use the work-room can provide normal conditions only as regards temperature and humidity of the air. We have found

it better to carry out much experimental and other work in various cages erected in the open. If we wanted normal soil conditions we could get them only by the use of soil cages outside of the insectary. For other work tree cages or ground cages of various kinds, with or without a weather-proof top, and erected on normal soil, have proved not only better but necessary. It is our belief now that no permanent insectary can supply this need.

In winter we have come to consider that the storage of hibernating material can be accomplished easily and satisfactorily without making use of a dismantled insectary. Such material can easily be maintained under thoroughly normal conditions in temporary shelters, or on the ground under the protection of wire screening, or in the soil, or elsewhere, as the case may be.

In our rather severe climate it has been found that the dismantled part of the insectary tends to fill with ice and snow in winter. This is apt to be destructive of concrete.

Finally, there is no opportunity for winter work with living insects or plants.

In the light of the above experience changes have now been made in the insectary as follows:

We have retained the closed room entire, the foundations, bins, etc., of the open room, the removable frame work as far as the eaves, and the removable screen sides. In place of the double canvas roof, we have substituted a regular greenhouse roof, permanently set with glass. Glass sash, put on with screws, take the place of the wire screen sides in winter. Steam heat is provided in the former open work-room during the cold season, which, with us, lasts five or six months. No steam pipes run into the small, enclosed room, which can be kept cold, cool or warm by opening or closing the door to the larger room and by the use of ventilators.

The cost of these changes, complete, was about $250. This included $115 for steam pipes, asbestos covering, steam trap, and the labor charge for running an underground main from a near-by building. The new glass roof and sides cost $95. The carpenter's bill was $40.

The present plan, therefore, is to transform the insectary into a greenhouse through late fall, winter and early spring or as much of that as seems desirable. In summer the glass sides will be removed, the screen sides substituted, the roof will be coated thickly with whiting and if this does not provide normal temperature a canvas roof will be added above the glass roof with an air space between.

By this means it is our idea to retain the usefulness of the structure for summer work as in the past, and to add to this an equivalent usefulness through the winter season, which has not heretofore been true.

Much experimental summer work will continue to be done in the open, away from any permanent structure as formerly. Winter storage for material will be provided elsewhere without difficulty, and in some cases with conditions more nearly normal.

PRESIDENT P. J. PARROTT: I have no doubt that some of the members have in mind either building a new insectary or rebuilding an old one. The paper is now open for discussion.

MR. W. M. WHEELER: Our experience coincides very closely with that of Mr. W. C. O'Kane's. We have a glass enclosed greenhouse which we use only for winter work. As much work as possible is done out-of-doors so that natural conditions can be secured. We have a shed under which we keep pupæ in the winter. This problem has been under consideration for some time, but we have not yet decided whether to construct a new insectary.

PRESIDENT P. J. PARROTT: The next paper is by Mr. F. B. Paddock on "Some Observations on the Bee Moth."

OBSERVATIONS ON THE BEE-MOTH

F. B. PADDOCK, *College Station, Texas*

The bee-moth (*Galleria mellonella* L.) is an insect which has been known as a pest for over two thousand years.[1] However, during that time it has received but little attention from entomologists, though its occurrence has been noted from time to time in several countries. In Germany the habits and life history were briefly given in some notes made by Dr. E. L. Taschenberg in 1880.[2] In the United States limited observations have been made upon this insect. Perhaps the account by Prof. A. J. Cook[3] is the most complete as he has brought together the opinions of several writers. As far as we have ascertained the bee-moth is now found in Italy, Germany, France, England, Ireland, India, Australia, and in most of the bee-keeping sections of the United States.

THE ADULT. The moth is about five eighths of an inch (15 mm.) in length, and has a wing expanse of about one and one-quarter inches (30–32 mm.). When the wings are folded, the moth appears ashy-gray in color, though the rear third of the front wing is bronze colored. The dense covering of scales on the wings and the body is easily rubbed off

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[1] Manual of the Apiary, A. J. Cook, p. 485. "These moths were known to writers of antiquity, as even Aristotle tells of their injury, . . . they are often referred to by European writers as a terrible pest."

[2] Inseckten Kunde, Vol. III, p. 251.

[3] Manual of the Apiary, A. J. Cook, pp. 482–487.

and is seldom present on the older moths. The males, which are slightly smaller than the females, are readily distinguished by a scallop on the outer margin of the fore wing and the absence of palpi.

The moths emerge entirely at night and usually during the early hours. In our cage experiments the moths started to emerge as early as 7 p. m. and none were observed to emerge after 9 p. m. During the day the moths seclude themselves from light and enemies and remain very quiet; in fact they are extremely hard to disturb and when forced to fly they act as though blinded by the light. An apparent exception to this is found in the females, for during the last two days of the oviposition period they are very active in depositing eggs. The males usually emerge a few days in advance of the females and live for a much longer time. In the case of the second generation it was found that the males lived an average of twenty-six days, which was twelve days longer than the average adult life of the females. The proportion of males and females is constantly changing throughout the generation but as a whole the number of males and females is about equal. The first and the last individuals to emerge in a generation are considerably smaller in size than the average, regardless of the sex. The last larvæ of a brood are always small as the food supply is never sufficient for all those which are present. A great many of these larvæ, though apparently not mature and forced into pupation, will transform into functional adults.

Mating has been observed but once and this was at 10 p. m. From this and the nocturnal habits of the insect in general, it may be assumed that mating occurs only at night. The mating probably takes place quite soon after emergence but there is no positive proof on this point. Females which were only one and one-half hours old were killed and examined to determine the condition of the eggs. It was found that at this time fully two thirds of the eggs were of full size and were well down in the oviducts though not packed so closely as was found to be the case in older moths. If mating does occur soon after emergence, some little time elapses before the beginning of egg deposition. For the second brood there is a period of six days between the emergence of the female and the first oviposition. This period, no doubt, varies with the different generations.

In the cages where empty comb was supplied, the eggs were always laid in cavities and if possible in such cavaties as were well protected. Only one egg is deposited at a time, though in working over a small piece of comb the eggs may be placed close together, apparently in masses. The eggs are always securely glued to their resting place; usually the shell will break before the egg is loosened. The number of eggs which are deposited by one female has not been ascertained

but moths which had not deposited eggs were killed and the eggs in their ovaries counted. The average number of eggs counted was 1,014. The time consumed in laying the full quota of eggs varies with the generation, averaging nine days in the first and seven days in the second.

THE EGG. The egg is elliptical, measuring about one fiftieth of an inch (.48 mm.) in length. The shell is pearly white in color and is slightly roughened by wavy lines running across it diagonally at regular intervals. Unless deposited on dark comb the egg is very difficult to see. The egg stage of the first brood averages twelve days and of the second only ten days.

THE LARVA. The larvæ when first hatched are white in color and one eighth of an inch (3 mm.) in length. Entrance into the comb is completed within two hours after hatching. This is made at the top of the cells between the cell walls. This entrance is soon shaped into a tunnel directed toward the center of the comb and is continued till the midrib is reached. The larvæ tunnel along the midrib, at first making only passage ways. Very soon these are outlined with silk threads which the larvæ spin wherever they travel and shortly these runways are densely covered. In a short time the center of the comb is only a mass of webs and refuse. After the midrib is destroyed the larvæ eat the walls of the cells, working outward parallel to the midrib. The cell walls are entirely eaten away but normally the tops of the cells are not disturbed so that the form of the comb remains unchanged. If the food supply is very short the larvæ will work over the refuse which contains considerable wax in small pieces. The length of the larval period of the first brood is forty-five days and in the second brood this period is shortened to thirty-five days.

The cocoon may be spun at the end of the feeding gallery or in the refuse but the most common place is about the hive body. Such places are the corners, between the hive-wall and the ends of the frames, and in the "bee space" at the ends of the top bars.

THE PUPA. The change from the larva to the pupa takes place during the night. When first formed the pupa is white in color but this darkens with age so that the old pupa is a dark brown. The pupæ average two thirds of an inch (14–16 mm.) in length. In the second brood the total time from the starting of the cocoon to the emergence of the moth is fourteen days.

LIFE HISTORY. From the work which has been done in trying to identify the generations of this insect, it appears that there are three at College Station. The third is not nearly as large as the first two, due to the fact that a portion of the second brood of larvæ do not pupate until late fall. There is a decided overlapping of generations,

which has made it difficult to determine the exact number that occur in a year. At most any time that an infested hive is examined all stages of the bee-moth may be found. From this it was generally assumed that the life history was short and that there were several generations each year.

In well-protected hives the development may continue throughout the year without interruption. But usually the winter is passed with about two thirds of the insects in the larval stage and the remainder in the pupal stage. Warm spells during the winter may cause some of the moths to emerge from their cocoons. In the laboratory many moths emerged when the temperature was maintained at 60° F. Such moths do not reproduce in localities where freezing temperatures are at all frequent. Even the most vigorous moths, when exposed, cannot withstand a freezing temperature for more than three days. Moths in well-protected places cannot survive an outside temperature of 26° F. longer than five days. The moths are never active during the day when the temperature is below 50° F.

For College Station, the following life history and duration of broods has been carefully determined.

The maximum number of moths which mature from the overwintering larvæ and pupæ appear about the first of April. These moths are active for some time before any eggs are deposited and it is the middle of April before the eggs are laid for the first brood of larvæ. Usually twelve days are required for the eggs of this brood to hatch, so by the first of May most of the first brood of larvæ are out. The larval period of this brood is quite long, most of them feeding at least forty-five days before completing their growth. A majority of the larvæ of this generation are ready to pupate by the middle of June, but there is a considerable variation in the rate of growth, as some of the larvæ feed for six weeks longer before completing their growth. The pupation of the first brood occurs during the last two weeks in June and by the first of July some of the moths of the second generation are to be seen.

The moths of this generation emerge at about the same time and give the impression of constituting a very large brood. Most of the eggs are laid very soon after the emergence of the moths and by the middle of July all of the eggs for the second brood of larvæ are deposited. The higher temperature at this time of the year shortens the egg period, only ten days being required for these eggs to hatch. There is a considerable variation in the maturing of this brood of larvæ. Normally the larval period is shorter than for the first brood and by the first of September many of the larvæ are mature. Some of the larvæ, however, may continue to feed for as much as four weeks longer and then pupate.

Some of the larvæ which mature early in September may pass through a short pupal period and soon emerge as adults. This accounts for the appearance of a number of moths about the first of October. This generation is usually small and scattered and many of the larvæ which result from the eggs of these moths seldom reach maturity. Some of the larvæ of the second generation do not pupate during the fall, but live over the winter in the larval stage and pupate the following spring.

The following summary shows the stages of the bee-moth which normally occur each month of the year at College Station:

April: Moths reach maturity from the over-wintering larvæ and pupæ.
 Eggs are deposited.
May: Eggs hatch.
 Larvæ are about three-fourths grown.
June: Larvæ are reaching maturity.
 Some pupæ.
July: Pupæ.
 Adults of the second generation.
 Eggs deposited by the second generation of moths.
August: Larvæ of the first generation.
 Pupæ of the first generation.
 Moths of the second generation.
 Eggs of the second generation.
 Larvæ of the second generation.
September: Pupæ of the first generation.
 Moths of the second generation.
 Eggs of the second generation.
 Larvæ of the second generation.
 Pupæ of the second generation.
 Moths of the third generation.
 Eggs of the third generation.
October: Larvæ of the second generation.
 Pupæ of the second generation.
 Moths of the third generation.
 Eggs of the third generation.
November: Larvæ of the second generation.
 Pupæ of the second generation.
 Larvæ of the third generation.
December: Same stages as during November.
January: Same stages as during November.
February: Same stages as during November.
March: Pupæ.

NATURAL ENEMIES. Three hymenopterous parasites of the bee-moth have been recorded. One is a chalcid, *Eupelmus cereanus*, found by Rondani in Italy; another is a braconid, *Bracon brevicornis* Wesm., which was found by Marchal in France; the third species is *Apanteles lateralis* Halid., recently found by A. Conté in France.[1] This last

[1] "A Hymenopterous Parasite of the Bee-Moth," A. Conté. (Compt. Rend. Acad. Sci. Paris, 154, pp. 41–42.)

species was found near Lyons where it spread very rapidly. It is apparently of considerable importance since it has also been reported to attack other Lepidoptera in England and Germany.

A small red ant, *Solenopsis* sp., has been found an enemy of the bee-moth, as many of our cage experiments were destroyed by this ant killing the moths and larvæ. The attack is made upon the moths in the day when they are at rest and the abdomen is all that is carried away. The larvæ are attacked during the day and those which are not well protected are sure to be eaten by these ants.

ARTIFICIAL CONTROL. Unfortunately, none of the above mentioned parasites of the bee-moth have been observed in Texas. Therefore, it is necessary for the bee-keeper to depend entirely upon artificial control of the pest. For this purpose fumigation has proven the best means of fighting the pest. In our experiments two materials were chosen, carbon bisulfide and sulfur.

From these experiments it is evident that only extremely large doses of sulfur will affect the eggs of the bee-moth. The results indicate that the fumes are not ordinarily penetrating enough to be effective if the larvæ are well protected by their webs.

In the experiments with carbon bisulfide it was found that the eggs of the bee-moth were not injured by the ordinary doses. These experiments, however, showed the effectiveness of the fumes of carbon bisulfide upon the larvæ of the bee-moth. It was found that the pupæ are susceptible but a longer confinement in the gas is necessary to kill them. The moths were also found very susceptible to the fumes as they were killed in twenty minutes after being confined.

So successful was carbon bisulfide in the control of the bee-moth that tables were compiled showing the dosage necessary for varying numbers of supers and hive bodies containing infested material and these amounts have been found effective in actual practice.[1]

MR. A. F. CONRADI: Do you find ants in the hives?

MR. F. B. PADDOCK: Ants in beehives are very rare.

PRESIDENT P. J. PARROTT: The next paper will be read by Prof. Glenn W. Herrick on "Oviposition of Two Apple Pests."

[1] The tables are given in Bulletin 158, Texas Experiment Station, "Investigations Pertaining to Texas Bee-keeping."

THE OVIPOSITION OF TWO APPLE PESTS

By GLENN W. HERRICK, *Ithaca, N. Y.*

THE GREEN FRUIT WORM, *Xylina antennata*

For the past two seasons the green fruit worms have been prominent among the insect pests of apples, pears, and, in some instances, sour cherries. In 1896 they were also abundant in western New York and caused considerable injury. At that time, Professor Slingerland made observations on the injuries, distribution, habits, and life histories of the three species concerned.[1] He surmised that the moths deposited their eggs in the spring. It is stated in a newspaper article that appeared in the South that the eggs are deposited in the spring on the undersides of the leaves. So far as the writer is aware the eggs of *Xylina antennata* have not been described or figured.

In the spring of 1913 several battered specimens of *Xylina antennata* were brought to the writer from Holley, N. Y. The moths were reported as occurring in abundance in an apple and pear orchard. We immediately wrote and requested that more specimens be sent and on March 22 four fine fresh moths were received in good condition. It was amazing that they had been able to pass the winter so well preserved. It is, of course, possible that these moths had transformed from overwintering pupæ, but hardly probable considering the early date at which they appeared.

These moths were placed in a breeding jar in the insectary with some apple branches that had been brought into the house early and were just coming into leaf. Some moistened sugar in a shallow dish was set in the cage where the moths could find access to it. On March 23 several eggs were deposited on the branches. They were laid separately in the scars of the branch (Fig. 16), particularly in the leaf scars of last year's terminal buds.

The egg is whitish or flesh-colored and inclined to pinkish. It is circular, somewhat dome-shaped but much flattened on top. The base is flat and the sides are ridged and grooved. There are apparently eleven primary ribs converging toward the micropyle with usually two secondary ribs between each pair of the primaries. In general appearance, the egg is remarkably like that of the cotton leaf-worm moth. In diameter the eggs range from .55 to .65 mm. The vertical diameter is somewhat less. By March 25 the eggs had turned much darker and were more pinkish in hue. They gradually grew darker and hatched on April 1. The incubation period then, under the conditions in the insectary, was nine days.

We have said that the eggs were deposited in the leaf scars on the

[1] Bull. 123, Cornell Univ. Agri. Expt. Stat. 1896.

branch. On March 29 we transferred the four moths to a new cage containing a short apple branch with a few small leaves. Here the moths deposited more eggs, three of which were placed on the undersides of the leaves.

On April 19 the writer spent a day searching for eggs in the apple and pear orchards near Holley in which the moths were found. It was an exceedingly raw, uncomfortable day with a strong wind from the north. In the whole day's search we were rewarded with only one egg. This was deposited near the tip of a small branch of pear in a leaf scar. Undoubtedly there were more eggs present in the orchard, although it was perhaps a little early in the season for them to be deposited. At any rate, the larvæ were rather numerous in this orchard later in the season.

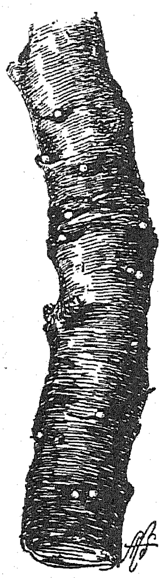

Fig. 16. Eggs of the green fruit worm on a twig.

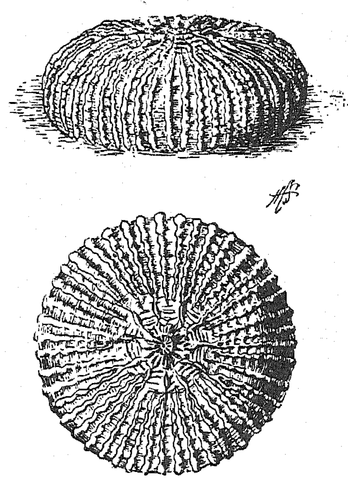

Fig. 17. Eggs of the green fruit worm greatly enlarged.

On this same day, April 19, Mr. R. W. Braucher, who had seen the eggs in the insectary and whom I had asked to watch for them in his orchard work, sent me a single egg laid on an apple bud near Batavia, N. Y. There seems to be no question but that at least some, if not the majority, of the eggs of this species are laid on the branches before the leaves appear.

The larva is pale green with a brownish green conspicuous head. When they were five days old they measured about 3 mm. in length. On the dorsum are two rows of tiny, black tubercles, each tubercle

bearing a black bristle. Just above the spiracles on each side is a row of black tubercles. The thoracic legs are brownish-green. In the second instar the larva begins to assume the appearance of the adult. The rows of tubercles have become whitish in color and two faint whitish lines begin to show along the dorsum.

The young larvæ eat almost entirely on the undersides of the leaves. They eat small, shallow cavities in the epidermis of the leaf but as they grow they eat holes entirely through the leaf. The larvæ under observation came to maturity on a diet of leaves and buds.

The Palmer Worm, *Ypsolophus pometellus* (or *ligulellus*)

In the past the palmer worm has been notable for its "ups" and "downs." Heretofore it has been considered rather an erratic pest of apples but apparently it is becoming a much steadier and more reliable enemy of the fruit-grower. In 1900 it appeared in western New York in great numbers and caused much injury. Since that time it has apparently been present more or less every year in the orchards of the state and during the past two seasons has been of considerable importance.

In 1900, Professor Slingerland worked out the life history of the palmer worm in some detail and endeavored to get the moths, which appeared during the first part of July, to lay eggs.[1] The moths lived in cages until about November 1, or nearly four months, but did not deposit eggs. It was evident that the moths hibernated and Slingerland hazarded a guess that they laid their eggs in spring on the branches or opening leaves in May.

On May 21 of the spring of 1913, Mr. R. W. Braucher sent me some moths for identification. He said they were rather numerous among the apple trees and that several were in the open air insectary which was located in the orchard. I recognized the moths at once as those of the palmer worm. They were in remarkably fresh condition and the writer at once asked Mr. Braucher to either send several to Ithaca or to confine them in cages there in the field in order to obtain eggs if possible. On the receipt of my letter Mr. Braucher was able to capture only two moths which he confined in an ordinary jelly tumbler on May 27 with a few apple leaves. On the morning of the 31st of May he found a number of eggs on the leaves, which he immediately sent to me.

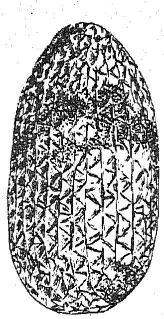

Fig. 18. Egg of the palmer worm moth, greatly enlarged.

[1] Bull. 187, Cornell Univ. Expt. Stat. 1901.

In an examination of the leaves which were badly wilted I found in all fourteen eggs. They were tucked away among the hairs on the undersides of the leaves. Some were deposited in the angles of the veins, but the majority were scattered irregularly over the surface. They were very small and inconspicuous. The eggs varied somewhat in shape but, in general, were elongate oval and slightly pinkish in color at the time they reached my hands. Each one was sculptured with an irregular network of veins. The measurements of four ran as follows:

Length	Width
.52 mm.	.29 mm.
.49 mm.	.29 mm.
.50 mm.	.30 mm.
.49 mm.	.30 mm.

Braucher says that probably the eggs were laid on the 30th of May as that was the first warm day they had had since he put the moths in the glass. The eggs hatched on the 6th of June, thus giving an incubation period of about seven days.

The drawings by Miss Stryke show well the shape and characteristics of the eggs of these two apple pests.

President P. J. Parrott: The data given in this paper is of special interest to economic entomologists in New York because, as Professor Herrick has said, there has been little or no definite knowledge on the oviposition habits of these two pests. Not knowing that Professor Herrick has been working with the green fruit worms, Mr. Fulton of the Geneva Station has been studying also the life histories of several Xylina moths. He has succeeded in obtaining eggs from six or seven species. The eggs of several of these are very similar in appearance.

The next paper will be presented by Prof. Herbert Osborn, entitled "Economic Notes on Leaf Hoppers in Maine."

ECONOMIC NOTES ON LEAF HOPPERS IN MAINE

By Herbert Osborn, *Columbus, O.*

(Withdrawn for publication elsewhere)

President P. J. Parrott: We will now listen to a paper by Prof. R. A. Cooley, entitled "Notes on Two New Pests of the Currant and Gooseberry."

TWO NEW INSECT PESTS OF CURRANTS AND GOOSEBERRIES

By R. A. Cooley, *Agricultural College, Bozeman, Montana*

The Montana Experiment Station is giving some attention to the life history and means of controlling the currant fruit fly (*Epochra canadensis* Loew), and in this connection has found a small curculio, *Pseudanthonomus validus* Dietz, destroying the fruit of the currant in a manner very similar to that employed by the dipteron mentioned. The U-shaped larva of this beetle, feeding in the seeds, causes the fruit to turn prematurely red and drop to the ground. The injury occurs somewhat earlier in the development of the fruit, than in the case of *E. canadensis*. No injury is done to other parts of the plant so far as we have observed.

This species has been under observations in the college currant patch, of about an acre, for three seasons. In 1911 and 1912, the injury was severe, but no accurate estimate was made; in 1913 careful countings and estimates showed a destruction of fully 40 per cent of the fruit that set. Compared with the currant fruit fly in 1913, detailed countings of each kind of larvæ in four lots each of fifty injured currants, gathered from both the bushes and the ground, showed the weevil to be more abundant by three to one. From our experience, it is clear that while in some years the fruit fly is more abundant, in others this weevil is more destructive, and the two together in average years destroy much of the crop.

The adults appear in the spring by the time the young currants are setting. Numerous punctures are made with the long beak on different parts of the fruit, particularly around the point where the stems are attached, and in the pits by the stem the eggs are laid. The larvæ hatching from the eggs pass to the center of the fruit and begin feeding on the small seeds. They reach full size by about the time the currants are full grown. The injuries caused by the beetles close around the stems result in a drying and weakening of the tissues at this point and the currants are easily broken off. It is probable that a considerable portion of the feeding is done after the currants drop and we have found the large larvæ and fresh pupæ in the shells of the fruit on the ground. The pupal stage is passed in the destroyed fruit. From the pupæ, the adults emerge, are found for a short time on the bushes and then burrow into the ground for hibernation.

The periods required for the development of the various stages have not been determined, but the approximate seasonal history is clear and may be summarized as follows: The adult beetles pass the winter in hibernation appearing in the spring and laying eggs on the young

fruit. Egg laying begins in Bozeman about June 1, and by about July 15 the bulk of the feeding is completed and pupation has taken place. The fresh adults begin to appear on the bushes about July 20 and continue until about August 1, when all have disappeared, having gone into hibernation.

Detailed descriptions and control measures are left for future publication. We are indebted to Mr. W. Dwight Pierce for the determination of the name of this beetle. Mr. Pierce has also determined for us a parasite which was bred in considerable abundance from this beetle as *Catolaccus* sp. The common name, "The Currant Fruit-Weevil" is proposed for this insect.

For several years we had noticed a peculiar injury to the tender, terminal growth of gooseberries and red and black currants in Bozeman. The leaves of the affected stems were distorted, undersized and showed distinct spots or markings which suggested the attacks of some insect with piercing mouth-parts. The injured stems were reduced in size and in length and, as all of the stems on the bushes were more or less affected, the bushes showed distinct injury. The cause of the injury was explained when in 1912, a large black thrips was found feeding on stems which showed such injury. A number of the living insects were placed on fresh gooseberry shoots in the insectary and the young were reared. Since then we have repeatedly found both adults and young on gooseberry and currant and it is perfectly clear that a definite and characteristic injury which at times may be rather severe is attributable to this species.

Specimens were sent to Mr. J. Douglas Hood of the United States Department of Agriculture, who found them to be of a new species which he names *Liothrips montanus* (See "Nine New *Thysanoptera* from the United States," J. Douglas Hood, Proceedings Biological Society of Washington, Vol XXVI, June 1913, p. 163).

More recently this insect has been found in Sixteen Mile Canyon in Montana, feeding on the native wild gooseberry (*Ribes setosum* Lindl.), and causing the same characteristic injury.

The details of the life history and habits have not been worked out, but the following notes may be given:

The adults appear on the bushes soon after growth starts and later, the young, which are bright red with black head and legs, may be found. The hatching of the young is strung out for several weeks. The first young appear about the middle of June and we have found young just hatched on July 12; in the latter part of July only adults are found and these disappear during the summer. The species apparently hibernated as an adult.

Preliminary tests with insecticides have been made, using commer-

cial lime-sulphur solution testing 27° Baumé, and with "Black Leaf 40" and soap, the tobacco extract being in the proportion of 1 to 1000. The lime-sulphur solution killed many of the thrips, but the "Black Leaf 40" was distinctly more effective, destroying practically all of the insects. The spraying was done on July 9, 1912.

At Bozeman this thrips is more particularly a gooseberry pest, but currants are frequently attacked. Of the two currants mentioned, the black species (*Ribes nigrum*) is distinctly preferred. As a common name for this insect we propose "The Currant Thrips."

PRESIDENT P. J. PARROTT: These insects discussed in this paper are examples of the surprises that attend the work of the entomologist. Recently our attention has been called to a snout-beetle that has never been recorded as being of economic importance, but which occurs on sandy soils in New York where peaches are grown. It appears in the spring and feeds on the young leaves of the peach. During some seasons it causes quite a little injury to young peach trees.

Adjournment.

Afternoon session, Thursday, January 1, 1.30 p. m.

PRESIDENT P. J. PARROTT: Dr. C. Gordon Hewitt will present the first paper on "The Occurrence of the Warble Fly (*Hypoderma bovis*), in Canada."

THE OCCURRENCE OF THE WARBLE FLY (*HYPODERMA BOVIS*), IN CANADA

By C. GORDON HEWITT, *Ottawa, Can.*

(Withdrawn for publication elsewhere.)

MR. HERBERT OSBORN: Have there been any recent importations from Europe?

MR. C. Gordon Hewitt: I don't know. Of course, we are receiving cattle from Europe all the time.

PRESIDENT P. J. PARROTT: Do you know anything about the distribution of *H. bovis* in the United States?

MR. C. GORDON HEWITT: Except for the reference of Johnson of its occurrence in Vermont, I know of no other records. My object in presenting this short paper is to have the entomologists in the United States on the lookout for this insect. The species in the United States has always been referred to as *lineata*.

PRESIDENT P. J. PARROTT: The next paper is by Dr. H. T. Fernald, on "Control of the Onion Thrips and Onion Maggots."

NOTES ON THE ONION THRIPS AND THE ONION MAGGOT

By H. T. Fernald and A. I. Bourne, *Amherst, Mass.*

The "Onion Blight" is very common and serious in the onion-raising districts of New England. The trouble is caused by *Thrips tabaci* Linde., which is widely dispersed over the country, and the loss caused by this insect is often great.

Studies on this pest extending over a period of about five years have now been completed in Massachusetts, and have given the following results:

The insect passes the winter as the adult in any protected places available. These are generally in the refuse left on the onion field, in rubbish heaps, or at the base of the grasses on uncultivated fields and along roadsides near the onion fields. In spring, soon after the onions come up, the insects leave their winter quarters and pass to the plants, then usually an inch or two high. They locate on the leaves and begin to suck the juices and breed. The effect of the feeding upon the plant is first shown by the leaves attacked, which begin to bend rather sharply downward, bringing the thrips within the protection formed by the bend. This is due to the abstraction of sap from one place while the rest of the leaf is growing rapidly, so that in consequence the injured point is as it were, grown around by the uninjured portions. This condition is often evident by the time the plants are three inches high, and increases during the season, while other leaves become involved as the insects spread. Dying back from the tips soon appears, and in serious attacks either the entire plant may die or the bulb make only partial growth.

In testing different methods of control for this pest, the rather unusual methods used for raising this crop should be kept in mind. In New England at least, the land is fertilized broadcast and the seed sown in rows by seeders, and covered by a roller behind the seed spout. The rows vary in accordance with the ideas of different growers but their average distance apart is perhaps fourteen inches or less. The seed is sown so closely in the rows that some thinning is usually necessary where germination is complete, and a field of vigorous plants cannot be traveled over with a spray pump after these are more than six inches high, without causing serious injury to the leaves which tend to spread out, laterally. Any treatment, therefore, must be while the plants are small, and in some cases at least, the thrips spread to the field after the plants are really too large to permit of treatment without considerable injury.

The experiments were conducted on river bottom land used almost

exclusively for onion growing, the fields covering from six to ten acres and separated only by narrow strips of grass used as roads. Kerosene emulsion 1 to 5; whale oil soap, and tobacco whale oil soap were used in the tests. To bring the cost of treatment, particularly labor, within reasonable limits, a pump was placed on a hand cultivator and geared to the cultivator wheels while the discharge pipe was arranged to distribute to five nozzles placed opposite five rows, so that this number would receive treatment at once. It was soon found that with any gearing available a rapid walk was necessary to develop sufficient pressure, and that the speed required to obtain this pressure meant that a thorough spraying was impossible before any given plant had been left far behind. Possibly this mechanical defect might have been remedied, but hand tests of the material showed that it was practically impossible to reach enough of the thrips to make it worth while. The onion leaf is quite repellent to these materials, and as soon as the thrips has worked long enough for the leaf to bend downward somewhat the insect can be reached only by an underspray, and large numbers will be missed in any case.

As hand work at leisure was out of the question because of its cost, and as even with an effective machine an underspray cannot long be used before the growth of the plants would prevent its use by causing injury during the process, these treatments were given up. Instead, the careful destruction of all refuse after the crop was gathered, and the burning over of all strips of grass through and around the fields was advised. This practice has now been carried out for several seasons with good results. The growers of one large area have coöperated in this, and now find few thrips, and those which do appear, are most noticeable near the boundaries of the land which they control, apparently coming in from places where burning over has not been done in early spring. The adult does not appear to fly far of its own volition, and unless carried by strong winds it would seem probable that onion fields can, to at least a considerable extent, be kept clear of the thrips by running fire over all places near, in which they hibernate.

Another pest which has much injured the onion crop in Massachusetts is the onion maggot, the loss in some cases running as high as a hundred dollars per acre. In order to discover if possible some way in which the ravages of this insect may be prevented, experiments have been conducted for several years at the Experiment Station.

A preliminary study of the literature of the subject showed that numerous recommendations as to methods of control had already been made. A more critical examination, however, suggested the belief that some of these at least were more theoretical than practical,

and that it was extremely doubtful if any of them had ever been tested over as large an area as a single acre, even. In several cases it seemed probable that the person concerned had really experimented with the cabbage maggot and had merely inferred that a treatment successful there would also prove efficient in onion fields, not realizing that the different method of growing onions might affect the results.

After a prolonged study of the treatments advised, eight of the most promising were selected for trial, the others being prohibitive on their face, either because of the difficulty of obtaining the material in sufficient quantities for extensive experiment, its cost, or an evident great expense in its application. These eight were: carbon disulfid; nicine; powdered hellebore; hellebore decoction; soap wash; carbolic acid and lime; kerosene emulsion; and carbolic acid emulsion.

Time does not permit the presentation here of the details of the tests, which are given in the 25th Annual Report of the Massachusetts Agricultural Experiment Station. The results, however, are briefly as follows:

The carbon disulfid when placed near enough to the plants to protect them from the maggots, killed most of the plants. It is possible that a long series of tests would show that a certain amount placed at some certain distance from the plant would give protection without injury, but the application of any treatment, with the accuracy this would require, to a ten-acre field would be impossible except at a prohibitive cost. If a second treatment were necessary as would probably be the case, it would become still more impracticable, while the cost for a single application would be from \$12 to \$14. For these reasons, therefore, the carbon disulfid method may be dismissed as not feasible.

Nicine was tested mainly from curiosity to learn if it was an insect repellent as it was claimed to be. It was found to have no protective value, and at the prices quoted its cost would be prohibitive in any case.

Powdered hellebore dusted along the rows cost over fifty dollars for each application, including the labor. The treatment would need to be repeated at least once, and probably twice, bringing the expense too high. The results also, were far from satisfactory.

Hellebore decoction prepared according to Smith's directions (N. J. Bull. 200) seemed to give no protection whatever to the onions and the cost of material and its application three times would be greater than the average loss without treatment, even if good results had been obtained.

Soap wash using one pound of soap in ten gallons of water, poured along the rows, three times at intervals of ten days, gave only moder-

ately good results. The cost of the soap and of its preparation and application came to about $20 an acre for each application, bringing the cost too high to make it a desirable treatment.

Carbolic acid and lime also failed to give good results. Either the coating around the plants was too thin or the maggots went beneath it. After every cultivation or row weeding it was necessary to repeat the treatment, and the infestation of the treated rows was as great as of the untreated check rows. The cost of the material was not great but the application had to be carefully made in order to obtain a complete crust around the plants, and this took time. The total cost for one application finally figured out at about $23 per acre, which in view of the repetitions necessary after each cultivation would make the cost too great even if it had been effective.

Kerosene emulsions, one part to nine; to fourteen, and to nineteen of water, were applied like the soap wash and repeated at intervals of ten to fourteen days. The different strengths seemed to give no difference in the results and no injury to the plants or protection from the maggots was found. The total cost for one application per acre varied from about $20 to $24, which for three applications would be too high.

Carbolic acid emulsion gave the best results so far as protection from maggots was concerned, though not being entirely effective. The cost for the four treatments necessary would come to from $35 to $50.

The conclusions drawn from these tests were that none of the treatments are entirely satisfactory and that most of them are in any case prohibitive because of their expense. Accordingly, the problem may be formulated somewhat as follows: To find some material which will destroy or repel the onion maggot at a total cost of less than $50 per acre.

The greatest item of expense is, of course, the application of the material, and any method which will reduce this is of value. Each repetition of the application rapidly increases the cost, and if a substance can be found with which a single treatment will be sufficient, this will be a great advantage. If, then, this treatment can be combined with the planting, the extra cost will be mainly that of the material.

During the past season, therefore, an attempt has been made to discover some repellent which could be fed on to the seed from a supply tank just behind the seed spout and in front of the roller, which would keep the maggots away.

A number of materials were tested for this purpose, and it was found that some are injurious to the seed, preventing its germination, and

that others are too costly for use, even in this way. One or two promising substances have been found, however, and farther tests of these will be made during the coming season, as it is, of course, unwise to rely upon the results obtained in a single year.

Mr. Herbert Osborn: Have you noticed any effect of dry season on the breeding of onion thrips and does a dry season show any reduction in the injury caused by this insect?

Mr. H. T. Fernald: Dry seasons may check the injury to a certain extent after a time, but at first the insects seem to increase rapidly. At one time I thought this insect was distinctly a dry season species. Later it did not seem to be affected so much by dry weather.

Mr. Herbert Osborn: My experience has been that it migrates into onion fields during the dry periods.

Mr. H. T. Fernald: Dry weather usually begins in New England about the 1st of July and at that time our onion fields are so thoroughly stocked with thrips that no further migration to them is necessary.

President P. J. Parrott: Is this species a common pest on cabbages in Massachusetts?

Mr. H. T. Fernald: I have not noticed it to any extent.

President P. J. Parrott: As regards the maggot, Mr. Schoene has been working with a similar insect which attacks cabbage, and has found that carbolic acid emulsion is not a satisfactory treatment. We rely on screening the seed-beds to protect seedlings.

Mr. W. D. Hunter: Has anyone tried naphthaline? This substance has been found to be very destructive to several species of root maggots. I have tried it on cabbage, turnips, and radishes, but not on onions, and it gave the plants practical immunity.

A member: I have tried naphthaline alone and in combination with other materials and found that it controlled both the maggots and the growth of the plants.

President P. J. Parrott: One of our cabbage growers has made it a practice of planting a moth ball with his early cabbages.

Mi. W. J. Schoene: The cabbages do not grow very well, however.

Mr. Henry Skinner: Naphthaline might be used in the liquid form. It is one of the best materials to use for household insects because it can be applied so as to seal every hiding place.

President P. J. Parrott: The next paper is entitled "A New Destructive Cutworm of the Genus Porosagrotis Occurring in Western Canada," by Mr. Arthur Gibson. It will be read by Doctor Hewitt.

A NEW DESTRUCTIVE CUTWORM OF THE GENUS POROSAGROTIS, OCCURRING IN WESTERN CANADA

By Arthur Gibson, *Chief Assistant Entomologist, Division of Entomology, Ottawa, Canada*

In June, 1911, reports reached the Division, from southern Alberta of extensive injury to grain crops owing to the ravages of cutworms. From material received two moths were reared which were determined at the time by Mr. F. H. Wolley-Dod as *Porosagrotis delorata* Sm. A brief record of one instance where a correspondent claimed to have lost 320 acres of wheat, before June 21, was referred to in my bulletin on cutworms (No. 3, Dominion of Canada, Division of Entomology, Frebuary, 1912), and Dr. C. Gordon Hewitt also referred to the outbreak in his annual report, as Dominion Entomologist, for the year ending March 31, 1912. This was the first occurrence on record of this cutworm as an injurious species; in fact, the insect had hitherto been looked upon as an extreme rarity in Canada.

During the first half of May, 1912, farmers in the neighborhood of Lethbridge, Monarch, McLeod, and other places in southern Alberta, noticed large numbers of the cutworms in their fields. Mr. W. H. Fairfield, superintendent of the Experimental Station at Lethbridge, reported that the first noticeable damage to crops was on May 6. A correspondent at McLeod, Alberta, 32 miles from Lethbridge, stated that the cutworms began to attack fall wheat about the middle of April. Other crops destroyed were spring wheat, when it came up about the beginning of May, oats, barley, beets, onions, cabbages, carrots, etc. Many acres which were in spring wheat, and which had been destroyed later, were sown to oats in early June, and this crop was also completely eaten. In some instances as many as three sowings were made. In the Lethbridge Land District, from the city of Lethbridge westward to Pearce, and northward taking in Diamond City, Monarch, Stanton and other immediate settlements, it has been carefully estimated that actually 33 per cent. of the grain sown was destroyed. From personal visits made to infested districts Mr. Fairfield stated that he was of the opinion that between 30,000 and 35,000 acres of grain had actually been destroyed by cutworms, in 1912, in the southern part of the Province of Alberta.

On May 10, 1912, larvæ collected at Lethbridge on May 6, were received at Ottawa. These were of different sizes from about half an inch to one inch in length. Some of these larvæ were full grown and entered the earth for pupation on May 28. The larvæ remained in the earth, no change taking place until June 18, when the first pupa was

observed. The moth from this emerged on July 19; others emerged later, the last issuing on August 21.

In view of the serious nature of the outbreak of 1912, Doctor Hewitt arranged for an investigation of life-history, habits, methods of control, etc., in the spring and summer of 1913, and I was instructed to plan these experiments and also to proceed to Alberta to begin the work and make a survey of the infested districts. Mr. E. H. Strickland was appointed to carry on the work in the field throughout the season to make a special study of this and other cutworms occurring in the province.

In the end of April and early May we found the cutworms fairly numerous, throughout the Lethbridge District, in spring wheat, fall wheat and oats. In certain places they were very numerous, as, for instance, at Iron Springs where they were present in some fields in numbers varying from 3 to 11 to the square foot. The larvæ on this date (May 6) were mostly from one fourth- to one half-inch long. In our field control experiments we divided infested fields into various sized plots, none smaller than one tenth of an acre each. These were treated with various strengths of Paris green, salt and sugar, mixed with moistened bran, and scattered, in the usual way, over the fields. London purple and lead arsenate were also used.

During our first series of experiments the weather was very dull and cool and the cutworms fed very little. The highest percentage killed in some of the plots was only 25 per cent. Even later experiments when the weather was warmer and the larvæ more active, unfortunately did not furnish satisfactory results. From observations made during the evening, by Mr. Strickland, it would appear that the habit of this *Porosagrotis* larva is to travel over the surface of the soil and when a suitable plant for attack is found, it immediately burrows and feeds just below the surface. One half-grown caterpillar was observed to crawl nine feet in fifteen minutes. If this underground feeding habit is fairly constant it will, of course, explain why we failed to get better results from poisoned bran. Further experiments will, of course, be conducted whenever the opportunity arises. It is interesting to note, however, that at Raymond, 26 miles from Lethbridge, in large fields of sugar beets the attack of 1912 was stopped within 24 hours after the bran was applied. The application of poisoned bran was made between the 10th and 15th of May, and the actual cost, including material and labor figured out at 30 cents per acre. When visiting Raymond on May 15, 1913, I was fortunate in reaching the sugar beet fields at a time when bran was being applied to protect this year's crop. Five men, a distance of 10 feet apart, were distributing the bran with both hands, from a sack hung in front of the body. The manager of

the sugar beet factory informed me that one man will cover 20 acres in a day. Five Japs distributed the bran over 30 acres in 3 hours—15 pounds of bran to the acre. One hundred pounds of bran poisoned with $1\frac{1}{4}$ pounds of Paris green, is used to cover 7 acres. No sugar or salt is added. About 1,500 acres of beets are under cultivation near the sugar beet factory.

DESCRIPTION OF LARVA. Length, when mature, from about $1\frac{1}{4}$ to nearly $1\frac{1}{2}$ inches; of a sordid, whitish, color; no markings on body. Thoracic shield brown with a whitish dorsal stripe. Spiracles black. Tubercles dark brown, setæ circled with white. Dark pulsating dorsal vessel, conspicuous in some specimens. Thoracic feet pale brown; prolegs concolorous. Head pale brownish almost concolorous with body, the only marking being a conspicuous band of dark brown on epicranium, bordering either side of clypeus and median suture, somewhat after the sides of the letter H; ocelli black; mouth-parts blackish.

STATUS OF THE INSECT. *Porosagrotis delorata* was described by Smith[1] from a single male specimen collected at High River, Alberta, which locality is 101 miles, by rail, from Lethbridge. From a study of the specimens which we have reared I am convinced that *P. delorata* is Morrison's species (*Agrotis*) *orthogonia*, described from Glencoe, Nebraska.[2] A specimen which I recently examined in the collection of Prof. T. N. Willing, of Saskatoon, Saskatchewan, and which had been collected at Regina, Saskatchewan, on August 10, 1904, was determined by Mr. F. H. Wolley-Dod as *Porosagrotis orthogonia*. In the *Canadian Entomologist*, XL, 102, March, 1908, Sir G. F. Hampson records a specimen under this latter name which was collected in Alberta.

MR. GLENN W. HERRICK: Was the poison mixed with dry bran?

MR. C. GORDON HEWITT: Enough water was added to make it easy to handle.

PRESIDENT P. J. PARROTT: The next paper is by Dr. W. E. Hinds entitled "Reducing Insect Injury to Stored Corn."

REDUCING INSECT INJURY TO STORED CORN

By W. E. HINDS, *Auburn, Alabama*

In economic value for the Southern States this problem is only second in importance to that of controlling the Mexican cotton boll weevil. The present interest in stored corn insect control is in some measure an outgrowth of the fight that is being made for better farming

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[1] Jour. N. Y. Ent. Soc. XVI, 87, 1908.

[2] Proc. Boston Soc. Nat. Hist., XVIII, 239, 1876.

in the boll weevil campaign, which involves the reduction of cotton acreage, diversification and rotation of crops, the increase of live stock production, etc. All of this means for one thing more corn and longer storage for part of the increased crop. Within the past few years, the boys of the South under the guidance of the Corn Club movement have repeatedly demonstrated that the South can produce larger yields of corn per acre than perhaps any other section of the country, and withal can produce it more economically than any other section. Alabama presents two records that may challenge the world. In 1911, a fourteen-year-old boy, whose father was a county demonstration agent, produced over 212 bushels of corn on an acre at a cost of 9.6 cents per bushel. In 1913 another Alabama boy produced 232.7 bushels on a single acre, but his cost was between 19 cents and 20 cents per bushel. There is no longer any question that the South can raise her corn. The real question now is, can she preserve it from insect injury during storage, so that she may steadily increase her production until she raises at least all that she needs and can profitably utilize in her home consumption, which is bound to increase greatly in the near future, for the South is apparently destined to become the greatest section in this country for increasing meat production upon the farm.

There are several species of insects concerned in the injury to stored corn, and their relative importance varies in different sections. The most generally important of these species include two moths: the Indian meal snout moth, *Plodia interpunctella* and the Angumois grain moth, *Sitotroga cerealella;* three or four small beetles known generally as enemies of stored products: the rust-red and confused flour beetles, *Tribolium ferrugineum* and *T. confusum;* the square-necked grain beetle, *Cathartus gemellatus* and the saw-toothed grain beetle, *Silvanus surinamensis;* and more important than all these put together in most of the territory within 200 miles of the coast through the South Atlantic and Gulf States and extending still further inland in Louisiana, Texas and through Mexico is the so-called rice-weevil, *Calandra oryza* L. This species is known so much more commonly here by the name of "black weevil" that we think this common name should be generally adopted. It is this species, the black weevil, that we have been studying especially and to which we shall refer particularly in the balance of this article. Fortunately, what is most effective for the control of the black weevil is effective likewise in reducing injury by most of the other species.

There are several phases to the question of loss caused by insects to corn, particularly during storage. This injury often affects seriously the value of seed corn in the South. Infested kernels are not

likely to germinate at all and if they do start the growth of the young plant is likely to be weak. This poor seed means often broken stands and weak or barren stalks which decrease yields generally. Beside this, the crop of early maturing upland corn is commonly seriously injured even before it is stored, and this injury is continued and multiplied during the storage. Late matured corn, such as is commonly produced on the wetter lowlands and river bottoms, is rarely seriously injured unless through being mixed with more heavily infested corn in storage. In the method of storage that is most common in the South, the corn is allowed to stand in the field until after frost occurs; then it is gathered, often when wet, with the whole husk left on and stored in very open cribs which are entirely unfitted for any fumigation treatment. The most common special practice for weevil control is to sprinkle the corn with salt or dust it with air-slaked lime, etc., as it is being stored. In these storage practices there are many elements that contribute to serious loss.

There is a large waste in the storage space required.[1] In studying several varieties of corn of widely different type, we have found that the space required to store corn that will yield one bushel of grain, is often from three to four times as great where it is stored with the full husk on as is required for the shelled grain. An average of the results for several varieties required for 56 pounds of shelled corn a year old, about $1\frac{1}{9}$ cubic feet; for the same corn, ears husked, 2 cubic feet; with "slipshuck" on, $2\frac{1}{2}$ cubic feet; and with the full husk on, 3.6 cubic feet.

The waste in actual corn destroyed is a yet more serious item. The corn crop of Alabama for 1912 was about 54,000,000 bushels. While this was less than two thirds of what the state used, it is probable that something like 10,000,000 bushels was carried through into the early summer of 1913 and suffered extensive insect injury. Much corn is simply riddled by weevils before the end of November. Chemical analyses together with weight determinations have shown that corn may lose fully two thirds of its nutritive value during a year's storage. The loss in feeding value is even greater since it becomes so repellant to stock that horses, cattle and mules and even hogs may reject it. Poultry alone eat weevily corn with relish. It is probably conservative to estimate the loss to Alabama's corn crop alone at 5 cents per bushel per month after November 1st, for about one half of our yield that continues in storage up to April and for all of the corn stored after

[1] There is quite a wide variation in the volume of given weights of corn shelled and on the cob and in the space required to store different varieties with and without husks, etc. The volume of 56 lbs. of shelled corn has varied as widely as from 1.04 to 2.08 cu. ft.

that time. On this basis, Alabama's loss last year would reach close to $4,000,000 for nutritive value alone. Certainly the protection of corn against a large part of such loss would pay a handsome return if it can be secured at anything less than an average cost of 5 cents per bushel for the entire yield.

The net result of these most common practices may be summed up in one sentence: Not only do they fail to reduce insect injury to stored corn, but in many ways they even contribute largely to increasing that injury. The reasons for this conclusion will be shown briefly in succeeding paragraphs and from the many observations and experiments made, we shall attempt to formulate some recommendations as to methods that shall have real effective value in reducing insect injury.

Some Preliminary Facts from the Life History of *Calandra oryza* L.

Under winter climatic conditions, that are normal for central Alabama, there is no reproduction among the black weevils during about two months, ranging from the middle to last of December to usually about the middle or latter part of February. Immature stages then occurring in corn kernels develop very slowly, if at all. If unusually cold weather occurs, temperatures going to 12° F. or lower, there may be a very large mortality among both adults and immature stages. When winter temperatures do not go below 20° F. the total mortality may not exceed 10 per cent from the beginning of November to the end of March. At the end of March, 1913, in examinations involving about 7,500 weevils, only 11 per cent were found dead. Most of the corn ears examined were stored with husk on and thus retained probably all weevils that had died thereon since the infestation began in July or August of 1912.

Oviposition is actively resumed in the corn bins with the advent of warm weather in spring, by March or April at latest, and the first real spring generation emerges usually sometime in May. Females deposit eggs at an average rate of about four per day in hard corn. Weevils leave the corn cribs and apparently go to the fields in large numbers during the warm days from the middle of March to October. The height of this movement, as shown by cage trapping tests, appears to occur during July, by which time the second summer generation is out in the corn cribs and the corn in storage is then usually in very bad shape, while that in the field is in condition for attack.

In the fields, however, we know of no spring breeding place. Weevils may be taken occasionally in the field and they feed upon a large variety of subjects, but normal breeding does not seem to begin out of

doors until corn has passed its "roasting ear stage" and begins to harden up. When this condition of corn occurs, no matter what the date on the calendar, weevils seem to be ready for it and then, for the first time, come to the corn fields in large numbers. In several cases where most carefully studied, the weevils seem to have come most abundantly from the direction of the nearest woods. The earliest maturing corn—regardless of variety—attracts them in greatest numbers and, naturally, the ears that have exposed tips and loose, open husks are then the first and the most heavily attacked. For a brief period most of the weevils may be found upon the earliest maturing and most exposed ears on the plants scattered within perhaps 100 feet of the outer edge of the field. Gradually they spread farther inward until they are all over the field but naturally the corn from the outer edges of the field and the poorly covered ears throughout the field will always contain more weevils than any other equal number of ears.

These observations, together with the common experience that early-matured upland corn is nearly always heavily infested, while late matured river bottom corn escapes with practically no injury, point clearly to the feasibility of trap planting to concentrate weevils and of so handling our corn crop upon storage that heavily infested corn may always be kept separate from slightly or uninfested portions of the crop and the former treated for weevil control or fed out first, while the latter may be carried through long storage without necessity of treatment and with little insect injury.

Futile Remedial Practices

We have referred to the common practices of allowing corn to stand in the field until after a killing frost, of storing while wet and with the husk on, of sprinkling with salt, etc., to prevent weevil injury. These, and many other popular ideas we have tested carefully both in the laboratory and in large out-of-door storage bins constructed especially for experimental work with the black weevil, and we have found in nearly every case that they have practically no value in weevil control. A few of these ideas deserve specific mention.

It is commonly supposed that by leaving corn in the field until after a killing frost occurs the weevils on it are killed and that injury during storage is reduced accordingly. On the contrary, ordinary killing frosts such as occur at the beginning of the cold season have no killing effect upon either adults or immature stages. Doubtless the motionless condition of benumbed adults on the cold morning following a frost has misled the casual observer into thinking them dead.

Storing with the husk on is generally supposed to give more pro-

tection to the grain. On the contrary, it insures practically all of the weevils being successfully transferred from the field to the crib and in the crib the husk gives far more protection to the weevils already at work on the ears than it does to the corn.

The practice of storing while wet or of wetting as it is being stored, is supposed to facilitate a heating of the corn which will destroy the weevils and not injure the corn. It is apparently true that it is possible by a natural heating of a mass of immature or damp corn to produce a temperature that will accomplish this result, and this does occasionally happen, but only in a very small fraction of 1 per cent of the attempts is the desired benefit achieved. It is safe to say that up to the present time we do not understand the necessary coincident conditions of degree of moisture, volume of mass, and tightness of crib, etc., well enough to advise anyone to depend upon this heating for weevil control. The much more common effect of this excess of moisture in the storage bin is to soften the grain so that the insects can work so much the faster and to multiply the molds and other fungi growing therein.

The salting of the corn renders the husks more palatable to live stock but, on the other hand appears to increase rather than reduce the insect attack. Salt naturally gathers moisture from the atmosphere in every prolonged period of high humidity and thus renders the corn softer and more susceptible to attack both of insects and of fungi. A practical test of this treatment with close observations as to the condition at beginning, during and at close of storage test, showed that the corn from the salted bin weighed only 0.9 as much for the same volume as did the average of nine other tests having corn from the same field, stored at the same time, also with the husk on but with no especial treatment. The corn from the salted crib was the lightest of any in sixteen tests and only 85 per cent as heavy as similar corn fumigated with CS_2 at time of storage or as untreated corn which had long, tight husk covering.

Weevil Resistance in Corn Varieties

It is a matter of common observation that different varieties of corn grown side by side, with all planting, cultural and soil conditions similar, may vary greatly in their susceptibility to or resistance to insect injury. The two most important factors in producing this variation are generally comparative rapidity in development to maturity of the grain and the relative length and tightness of the husk covering. For several years we have been growing side by side a number of the most promising weevil resistant varieties that we could secure and have compared these with commonly grown varieties which have

been included in the variety tests at the Alabama Experiment Station. We consider large yield, sound grain, thorough husk covering and pendent ears to be among the requisite characters and would rank varieties according to their possession of this combination of characters in largest degree. Work in breeding corn for these characters should give extremely valuable results in the near future.

Among the most promising varieties found to date are Experiment Station Yellow, a variety under selection for weevil resistance for many years past by the Alabama Experiment Station. It has repeatedly stood high in yield. About half of its ears are now pendent and about 80 per cent are exceptionally well covered. It also has a hard grain. Another variety, already widely planted, known as Whatley's Prolific has about 90 per cent pendent and 80 per cent of well-covered ears. Among less well-known varieties several deserve mention and further study. A new variety, known as Mayer's Prolific, supplied to us by Mr. O. H. Moyer of North Augusta, S. C., showed up remarkably well, having on 75 plants, 164 good ears of which 85 per cent were pendent and 97 per cent extremely well covered. There was almost no weevil work on this variety. Randall's Branch and U. S. D. A. variety No. 181 were quite good. Among varieties not especially resistant but widely planted, Hastings, Mosby and Marlboro Prolifics would rank quite closely together, while at the other extreme some large-eared varieties like Shaw and Henry Grady have a large percentage of ears with tips exposed and the weevil infestation usually runs high even before time for storage.

Recommendations for Future Practice

Looking at the problem from the point of view of protecting the 1914 crop as it is produced and stored, we may mention some of the main points in a system that will largely reduce the weevils and minimize loss during storage.

Seed Selection:—This should by all means be practiced in the field at the time of harvesting. Only at that time can proper attention be paid to several of the most important factors in corn improvement. If obliged now to depend upon crib selection, and the corn still has the husk on, we would select ears having tight husk covering in addition to other desired characters.

Trap Rows:—To protect upland corn, we should at planting time provide for a few rows to be planted either two or three weeks earlier or with seed of a more rapid maturing variety, so that it will mature earlier than the main crop and serve to concentrate the weevils thereabouts. Gather all ears with the husk on from these trap rows within six weeks after it passes the "roasting ear stage." This is to keep the

weevils on these ears and secure their removal from the field at such a time as we may have the maximum number of the old weevils thereon and before the first new fall generation will be ready to emerge and spread into the main crop. This main crop may also be harvested as soon as thoroughly matured.

Harvesting Methods:—Have the storage crib thoroughly cleaned and ready. For the main crop we would advise breaking the ears from the husk as it is gathered, thus leaving three fourths, at least, of the weevils in the field. Have the wagon-body fitted with a cross partition, so that the slightly infested corn may be kept separate from that already quite heavily infested. Of, if preferred, provide for the separation to be made as the corn is unloaded. Have boxes on each side of the wagon-body, or at its end, to receive the best ears from which the seed for next planting may be finally selected. At the crib in which corn will be carried longest in storage, leave only the soundest corn. Never mix good and bad ears in the long storage bin if possible to avoid it.

The many weevils that are shaken off into the bottom of the wagon should be swept out at some distance from the crib so that they will not be likely to find their way back to it. In these ways the storage period may be started with a minimum number of insects present.

Fumigation Treatment:—Where weevils are present in abundance at storage time and the corn cannot be fed out for several weeks, there is no better way to check insect injury therein than to fumigate with carbon disulphide. This should be done on a warm day and at least 20 pounds per 1000 cubic feet should be used. Small dosages are usually so much thrown away. A spring treatment in March is likely to be required and if the work is well done, there is little likelihood of another being needed. At this time of year fumigation is likely to have least effect upon the Plodias because the larvæ of that species wander away from the corn and seek pupation shelter in places where the treatment is not likely to reach them.

It will take many years to effect a general change in the methods of handling and storing corn in the South, but it certainly seems possible, through continued work along these lines, to save to this section a large part of an insect injury that now taxes us to the extent of many millions of dollars annually.

Mr. Henry Skinner: I would like to ask in what kind of receptacle the fumigation is done.

Mr. W. E. Hinds: Usually the entire mass of corn in the house is treated.

Mr. Henry Skinner: Are these temporary storage houses?

Mr. W. E. Hinds: No, they are permanent houses. We have advised many people to construct temporary fumigation bins.

Mr. Henry Skinner: It seems to me it would be feasible to have permanent storage houses suitable for fumigation.

Mr. W. E. Hinds: It is a question of expense. When a man has thousands of bushels of corn in storage it would be impracticable to construct fumigation cribs to retain the entire crop.

Mr. C. Gordon Hewitt: Is a single fumigation sufficient?

Mr. W. E. Hinds: All stages may be killed by one treatment but if many of the eggs were not killed a second fumigation would be necessary. We often make one in the early fall and another early in the spring.

President P. J. Parrott: Dr. C. Gordon Hewitt will present the next paper, entitled "Sterility of Oats caused by Thrips."

STERILITY IN OATS CAUSED BY THRIPS

By C. Gordon Hewitt, D.Sc., F. R. S. C. *Dominion Entomologist, Ottawa*

About five years ago specimens of oats with "blighted" ears or spikelets were received from Saskatchewan. The upper spikelets of the affected inflorescences were, as a rule, healthy, green and sound. The lower spikelets, however, were smaller, whitish and shrivelled and varied in size from slightly less than normal length to minute undeveloped ears. Specimens of oats similarly injured were received from correspondents in Alberta. A farmer who forwarded heads of oats bearing affected spikelets from Vancouver Island, B. C., stated that over 50 per cent. of a fourteen acre field of oats were attacked. In 1909, Mr. Angus Mackay, at that time Superintendent of the Dominion Experimental Farm at Indian Head, Sask., informed me that he had noticed the "Silver top" in oats for several years, but more particularly during the preceding year or two.

The discovery of dried up specimens of thrips in certain of the spikelets and in the leaf sheaths suggested that these insects might be responsible for the injury. Accordingly, in 1911 I investigated the matter more thoroughly in the experimental cereal plots, at the Central Experimental Farm, Ottawa, where injured or "blighted" spikelets of the same character were found in the oat plots, and it was clearly established that this form of sterility in the spikelets was produced by thrips. On these plots the common species and the one which was responsible for the injury was the Grass Thrips, *Anaphothrips striatus* Osborn.[1] Dr. W. E. Hinds kindly confirmed this determination.

[1] Bagnall (in "A Further Contribution towards a knowledge of the British Thysanoptera," Journ. Econ. Biol., 1912, p. 189) states "The Genus *Anaphothrips* Uzel should be known as *Euthrips* Targ.-Tozz."

Euthrips nervosus Uzel was also found. I was unable to find other records of this type of thrips injury at the time, except one which Mr. F. M. Webster showed me in 1910 in the Bureau of Entomology of the United States Department of Agriculture, Washington, D. C.; in this case *A. striatus* was recorded as injuring oats.

Since commencing this study several records have been given in European literature of thrips injury to cereals. Korolikoff (1910) has investigated a number of species of thrips injurious to cereals and grasses in Russia, in the neighborhood of Moscow. Straňāk (1912) has investigated the species of thrips which caused unusual injuries to grain crops in Bohemia in 1912. Rye was most seriously affected, from 25 to 100 per cent. being attacked, wheat varied from 5 to 70 per cent., barley varied from 5 to 40 per cent., and oats appear to have been the least attacked, varying from 2 to 20 per cent. On the average, 29 per cent. of the spikelets were wanting and in the remainder of the injured spikelets the development of sound grain had been inhibited. A number of species of thrips were found to be responsible for the damage.

In discussing "White-heads" or "Take-all" of wheat and oats [2] the writer of the article states that much shrivelling of the grain and bleaching or silvering of the inflorescence in cereals and wild grasses is due to the activity of *Thrips cerealium* Halid. Zimmermann (1911) refers to *Thrips cerealium* Halid. occurring on oats, and his observations in Europe confirm my own made at Ottawa, namely, that early flowering varieties are less injured; most injuries being found on the later varieties where the emergence of the inflorescence is delayed. Miss Ormerod (1892) also referred to the shrivelling of the grain caused by the cereal thrips. Taschenberg (1880) records the injury caused by *T. cerealium* Halid. to the developing grain of wheat, rye and barley.

Fletcher recorded the occurrence of "White-top" in 1888 in June grass (*Poa pratensis*) and also in timothy (*Phleum pratense*) and couch grass (*Triticum repens*). While "White-top" in wheat is usually caused by the wheat-stem maggot (*Meromyza americana* Fitch) I have found specimens of such white-top in wheat which were undoubtedly caused by thrips. Comstock (1875) was the first to refer to "Silver top" or "White-top" injury by *Anaphothrips striatus* to June grass and timothy, and other entomologists including Hinds (1902) have subsequently recorded similar observations. Fernald and Hinds (1900) in their account of the grass thrips, *A. striatus*, refer to its extensive injuries to June grass.

In all the accounts of the injury of *Anaphothrips striatus* to June

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[2] Journ. Board of Agriculture (London), Vol. 19, p. 1020, 1913.

grass and timothy, the "Silver top" appearance is apparently caused by the thrips injuring the stems of the plants and thereby cutting off the supply of sap to the inflorescence. The adults feed upon the leaves and external parts of the plants; the larvæ feed chiefly within the leaf sheaths. This type of "Silver top" injury produced by *A. striatus* in the grasses mentioned is totally different in nature and in manner of origin from the injuries in oats which I am describing in this paper.

DESCRIPTION OF INJURY. The injury is chiefly confined to the inflorescence or panicle; the leaves of the plants were not affected to any noticeable degree. The injured spikelets are usually cream-colored, shrivelled and thin in appearance, contrasting vividly with the healthy green and plump spikelets, which fact facilitates detection in the field. The sterile ears vary also in length, that is, in development. I have found a similar type of sterility produced by thrips (*A. striatus*) in *Stipa robusta*. While the sterile spikelets are usually confined to the lower part of the inflorescence, as shown in Fig. D, for the reasons mentioned later, they may occasionally be scattered through the inflorescence or occupy a terminal position (Plate 7, A and B).

PRODUCTION OF INJURY. On July 13, 1911, different varieties of oats in the experimental plots of the Central Experimental Farm, Ottawa, were found showing the characteristic "blighting" of the spikelets. It was possible at this period of growth to make an examination of a large series of plants of different varieties showing all stages of growth from the young plants with the inflorescence completely enclosed to the full-grown plants in which the inflorescence was fully developed and extended.

Anaphothrips striatus Osborn, which has been popularly named the grass thrips, was responsible for the injuries which I am about to describe. The insects, both adult and larvæ, feed chiefly within the leaf sheaths; few were found externally. The inflorescence is attacked before it leaves the leaf sheath which encloses it. In consequence of this the thrips were more abundant in proportion to the extent to which the inflorescence was still enclosed by the leaf sheath; the more the inflorescence was enclosed the greater was the number of the insects found. The adult and larval insects feed upon the developing spikelets and produce complete sterility in the same by sucking the ovaries and feeding on the young anthers, in some cases two or three larvæ could be found on the base of a single floret. No larvæ were found above the edge of the leaf sheath, though they were occasionally found on the stem of the inflorescence between the lower florets. The injury to the florets is effected while the portion of the inflorescence bearing them is retained within the leaf sheath. In cases where the inflorescence had left the leaf sheath and no sign of injury to the lower

spikelet was noticeable only an occasional thrips could be found, but where the inflorescence had not left or had only partially left the leaf sheath, in every plant I examined thrips were found in varying numbers; their activity on disturbance made it impossible to count them.

It sometimes happens that when the inflorescence is emerging from the leaf sheath, the tip of the inflorescence is accidentally retained in the leaf sheath while the middle portion continues to unfold, the inflorescence assuming the shape of a mark of interrogation (?) with the distal extremity fixed. When this occurs the distal portion of the inflorescence is usually attacked by the thrips within the leaf sheath with the result that when it is ultimately withdrawn the terminal spikelets are sterile (Plate 7, Fig. 1, B).

A study of the different varieties of oats showed that those varieties in which the inflorescence left the leaf sheath earlier suffered less from thrips injury, that is they had fewer sterile spikelets at the basal region of the inflorescence, than the varieties in which the inflorescence was later in leaving the leaf sheath. I have already referred to the similar observation of Zimmermann in the case of *Thrips cerealium.*

Extent of Injury. In order to determine the actual extent of the injury, as field estimates are rarely within a considerable percentage either way of the actual injury, I made actual counts of the sterile and fertile spikelets on each inflorescence of stems gathered from different experimental plots. From these counts the actual percentage of sterile spikelets was obtained.

With a view to eliminating the possible chance of error due to personal selection of the plants from which the counts were to be made, I had the plants collected from different plots by a person who was unaware of the purpose for which they were intended.

The following figures [1] give the percentage of *sterile* florets found on the stems of the oat plants of the different varieties thus collected:—

"*Excelsior.*" Outside plot, outside row. 12 stems counted.

Maximum sterile spikelets	52.2%
Minimum sterile spikelets	4.1%
Average sterile spikelets	30.9%

"*Abundance A.*" Outside plot, outside row. 13 stems counted.

Maximum sterile spikelets	42.2%
Minimum sterile spikelets	15.6%
Average sterile spikelets	25.6%

Outside plot, inside row. 14 stems counted.

Maximum sterile spikelets	43.4%
Minimum sterile spikelets	16.8%
Average sterile spikelets	26.2%

[1]As there is no real necessity for setting out the figures in detail, the maximum, minimum and average percentages only are given, but I shall be pleased to give the detailed counts to any investigators to whom the same would be of value.

Oats Showing Sterile Spikelets Caused by Thrips (Original).

It will be noted that in the percentages of "Abundance" given above there is practically no difference between the extent of the injury on the inside and outside rows of the plot, indicating an evenness in the distribution of the insect over the plot.

"*Abundance, Garton's Regenerated.*" Inside plot, outside row. 11 stems counted.

Maximum sterile spikelets	38.8%
Minimum sterile spikelets	6.4%
Average sterile spikelets	17.3%

"*Banner H.*" Outside plot, outside row. 15 stems counted.

Maximum sterile spikelets	55.2%
Minimum sterile spikelets	3.5%
Average sterile spikelets	29.5%

"*Banner M.*" Inside plot, outside row. 19 stems counted.

Maximum sterile spikelets	56.8%
Minimum sterile spikelets	14.2%
Average sterile spikelets	36.3%

From the above results it will be seen that the most seriously injured variety of oats of those examined was "Banner M," 19 inflorescences of which variety had an average of 36.3 per cent. of sterile spikelets. The variety least attacked was "Abundance Garton's Regenerated," 11 inflorescences of this variety had an average of 17.3 per cent. of sterile spikelets.

Reference has already been made to the greater liability to thrips injury of the late flowering varieties and the foregoing percentages support this opinion. The "Banner" variety is one of our late flowering varieties and both percentages and field observations showed that it was more subject to the production of sterile spikelets by the thrips. Mr. G. Hutton, who studied cereal crops in Alberta during the summer of 1913, informed me that "Banner" oats suffered most from sterile spikelets in Alberta where he noticed the occurrence of "white-ears" in oats near Red Deer and Athabasca Landing, Alta.

Description and Life History of *Anaphothrips striatus* Osborn.

The insect and what is known of its life history, etc., has been described by Hinds from whose excellent account the following has been mainly taken:

The length of the female (Fig. 19) is 1 to 1.6 mm. The general color is yellow with more or less dusky or brownish shading in some parts. Hinds states that the male is unknown.[1] I have never found male specimens, although Cary (1902) describes the male.

The eggs are reniform and vary in length from 0.265 mm. to 0.33 mm. and in width from 0.085 mm. to 0.145 mm. The full grown larva is fusiform and about 1.2 mm. in length.

[1] Hinds has informed us that he has found a few males since his memoir was written.

The life history is briefly as follows: The females continue to deposit their eggs on the leaves of the grass and the young larvæ develop through the fall until the snow covers the ground, but only the adults appear to survive the winter. The adults hibernate and appear to be able to withstand exposure to a temperature of −21° F. according to Hinds. In Canada, however, they are able apparently to withstand lower temperatures than this judging by the distribution of the injury.

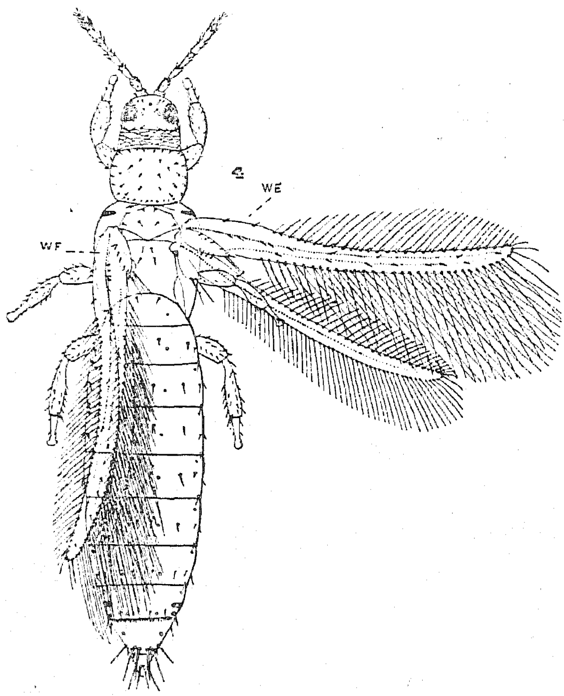

Fig. 19. *Anathrips striatus* Osb. (After Fernald and Hinds.)

In 1912, the lowest temperatures in Alberta were: Edmonton −46° F. and Calgary −30° F.; in Saskatchewan, at Battleford, −53° F., and Qu'Appelle −47° F.; in Ontario at Ottawa, the lowest temperature was −27° F. The females become active in the spring probably as soon as the snow disappears, and oviposition soon begins, lasting from four to six weeks in many cases. Each female is capable of depositing from fifty to sixty eggs. The eggs may be easily seen in the leaf by holding it before a light when they appear as small lightish spots; they may be separated from the leaf by stripping off the epidermis. The length of the egg state in the spring is from ten to fifteen days, and in the summer from four to seven days. The length of the larval stage

varies from two weeks in the early spring to about four days in midsummer. The winged adults appear in May or June. The whole life cycle occupies from twelve to thirty days. Korolikoff found that the species injurious to cereals which he investigated passed the winter in the green, soft tissues of the leaf sheaths of young plants, and that in the spring they migrated to the early cereals and later to the summer crops. He found that they migrated from one species of plant to another; for example, from rye to wheat and oats. He states that their injuries were caused chiefly by the fact that they feed upon the juices of the different parts of the flowers, and especially on the ovary, that is, in cereals, the young grain.

Other Species of Thrips Attacking Oats

Hinds. (l. c.) records the following species as attacking oats: *Æolothrips fasciatus* Linn., and *Limothrips avenæ* Hinds.

Control Measures.

As *Anaphothrips striatus* feeds on grasses and is able to migrate with the greatest ease, the difficulties of control would appear to be very great. The destruction of weeds, especially Graminæ, is essential, and this would also apply to volunteer crops. As the insects hibernate in places where they have been feeding, such as the stems of cereals which have been cut and have died down, under rubbish and in crevices, the hibernation period would appear to afford one of the best opportunities for employing control measures. Such measures would be of a cultural nature, such as deep ploughing of the soil. As an alternative and additional measure the burning of the stubble of an infested crop would undoubtedly destroy large numbers of the hibernating individuals. Grain which has been infested might be cut as early as possible to prevent the further reproduction of the thrips. After threshing, the screenings and chaff, which contain large numbers of the insects, should be burnt. Where early varieties of oats can be grown advantage may be taken of the fact that these are less likely to be injured than the later ripening varieties. Korolikoff recommends the sowing of "bait" or "trap" crops. He suggests that rye or oats sown round the fields under cultivation about a fortnight before the sowing of the winter cereals might attract the thrips and afford them shelter while the crops are growing. When the trap crops are removed later a large number of the thrips are removed also.

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MR. W. E. HINDS: It is a normal habit of these insects, particularly in the younger stages, to feed on the leaf sheaths or stems. I am sure that Doctor Hewitt's observations on the young actually feeding on oat stems is correct and I do not think there is any doubt of their being capable of causing the trouble mentioned in his paper.

MR. C. GORDON HEWITT: There are two types of injury; one where the stem is attacked and another where sterility is produced by the insects actually attacking the ovaries and anthers.

MR. W. M. WHEELER: As Doctor Hewitt has said, he has been dealing with a case of parasitic castration. Since the reproductive organs of the oat plant abort through lack of nutriment, we may conceive this castration to be brought about either by such insects as thrips or by parasitic plants, such as certain species of moulds.

MR. HERBERT OSBORN: We had a case at the Experiment Station in Iowa many years ago of apple blossoms being attacked by another species of thrips in which the same condition was produced. Sterilization of the blossom resulted before the bloom opened. We were unable to find any fungus disease there.

MR. C. GORDON HEWITT: This question of sterility was first sent to the Dominion Department of Agriculture with the idea that it was caused by bacteria or fungus.

PRESIDENT P. J. PARROTT: The next paper is by Mr. C. L. Metcalf, entitled "The Egg-Laying Habits of the Pecan Twig Girdler."

EGG-LAYING HABITS OF THE PECAN TWIG GIRDLER

By C. L. METCALF, *Raleigh, N. C.*

(Withdrawn for publication elsewhere)

MR. H. T. FERNALD: A resident of Massachusetts had a grove of pecan trees in the state of Mississippi and he found that this beetle

was causing so much damage that he secured no income from his investment, and finally sold the property at a loss.

PRESIDENT P. J. PARROTT: The next paper, entitled "Notes on the Life History, Distribution and Efficiency of the Egg Parasite of the Chinch Bug," will be presented by Mr. J. W. McCulloch.

A PARASITE OF THE CHINCH BUG EGG

BY JAMES W. MCCOLLOCH, *Assistant Entomologist*, and H. YUASA, *Student Assistant*, *Kansas State Agricultural College*

INTRODUCTION

Probably very few insects have received the attention from entomologists that the chinch bug has. Without a doubt the chinch bug is the most serious pest with which the farmers of the grain belt have to contend, and the amount of damage done by it in the last sixty years reaches into the hundreds of millions of dollars. Every experiment station in the area mentioned has at some time carried on investigations relative to the chinch bug, and it has been thought that the life history and economy of this insect was well understood.

Of all the staple crop insects, the chinch bug has been the only one for which there is no insect parasite. Prof. F. M. Webster[1] says "there may sometimes appear hymenopterous parasites of the eggs, but we have as yet no proof of the existence of such in this country, and only suspect the possibility of such a phenomenon because other allied species have similar enemies, which destroy their eggs." In April, 1913, the writers collected chinch bug eggs in the field which bore signs of parasitism, and later parasites were bred from these eggs which Mr. A. B. Gahan, entomological assistant, United States Bureau of Entomology, has described under the name *Eumicrosoma benefica.*

HISTORY OF DISCOVERY

In the course of a series of experiments conducted by the department of entomology of the Kansas State Agricultural College on the life history of the chinch bug, a large number of eggs were collected in the field to determine the first appearance of young bugs and the mortality of the eggs. The eggs, which were collected at different intervals and in different localities, were examined daily. While thus examining the eggs it was noticed that some of them were becoming dark in color instead of assuming the usual red coloring. These eggs were isolated and on May 19 there emerged from them three parasites.

[1] Bul. 69, U. S. Bur. of Ent.

Classification and Original Description

Eumicrosoma benefica Gahan is a very minute insect belonging to the hymenopterous family *Proctotrypidæ* and to the sub-family *Telenominæ*. Mr. Gahan [2] has erected a new genus and species for this insect. He places the genus near *Tiphodytes* but readily separates it from that genus by antennal and venational characters. The following technical description of the species is taken from Mr. Gahan's paper:

Female—Length .75 mm. Head from above more than twice as broad as long antero-posteriorly, the vertex faintly sculptured, face perfectly smooth and polished, the region below the eyes faintly punctured; antennal scape not quite reaching the front ocellus; pedicel longer than joints one and two of the funicle combined; funicle five-jointed, the joints sub-equal, not longer than broad; club four-jointed, joint one much larger than the last funicle joint, but smaller than the following club joints which are equal and sub-quadrate. Mesoscutum faintly reticulated anteriorly, the disc perfectly smooth and highly polished with a very few small round punctures; scutellum, postscutellum and true metanotum smooth without punctures; propodeum as described; anterior margin of the forewing to the apex of the venation with only a few short marginal cilia, beyond with long cilia, the longest being twice the width of the wing. First segment of the abdomen nearly twice as broad as long with coarse longitudinal striæ, second segment similarly striate at base and much more faintly so beyond to the apex.

Head and thorax shining black. Antennæ, palpi, legs including coxæ and the whole abdomen reddish yellow. Antennal pedicel and club slightly fuscous.

Male—Antennæ fuscous, sub-moniliform, without a distinct club; pedicel globose, thicker but not longer than the first funicle joint; funicle joints one, two and three slightly larger than the following; apical joint of the club as long as the two preceding joints combined; abdomen a little shorter than in the female and distinctly fuscous on the apical half. Otherwise like the female.

Life History Summary of Original Host

The life history of the chinch bug is so well known that it will only be necessary to give a very brief outline of it as it occurs under Kansas conditions. The chinch bug is found in all parts of Kansas, except in the extreme western counties. The adult bugs emerge from hibernation during the first weeks of April and eggs are found from the last of April to the first of July. The first brood reaches maturity during the early part of July and the eggs of this brood are found from the middle of July until October. The second brood begins to reach maturity about the last of August, although the majority do not reach maturity until the middle of September. These adults migrate to

[2] A large number of specimens of the parasite were sent to Mr. A. B. Gahan, entomological assistant, United States Bureau of Entomology, for describing. A full description of the genus and species appears in the Proceedings of The United States National Museum, vol. 46, pp. 442–43.

the grasslands where they pass the winter in the clump-forming grasses. The period of oviposition of the adults occupies the entire summer and with the exception of a week or two in July, eggs may easily be found in the field from the last of April until the first of October.

The Egg of the Parasite

Description—The eggs of the parasite have never been observed after they were deposited in the host's egg. Ovarian eggs or ova were examined many times. There never were found more than thirty ova in a female and these were grouped together in the ovary, their blunt ends towards the apex of the ovary and their tail-like portion bent around in every direction. Judging from the comparative size of the ova, the matured ovum is spatulate in shape with ovate body which tapers into a long stalk. The opposite pole tapers gradually and ends in a blunt point. The ovum, on an average, measures from .07 to .09 mm. in length and from .02 to .03 mm. in width. The stalk is about two fifths of the entire length and is slender and cylindrical. The micropyle is located at the tip of the stalk. The ovum is nearly transparent and the granular character of the cytoplasm is plainly visible. The nucleus, which is comparatively large, is located as a rule near the blunt end of the ovum.

Length of Egg Stage—So far it has not been possible to find the egg of the parasite in the host, and so the exact length of the egg stage has not been determined. However, the very young larva has been found shortly after it has hatched, and thus the time between oviposition and the time the young larva was first seen varies from two days to about a week.

The Larva of the Parasite

Description—Since it has not been possible to get the larva of the parasite out of the host's eggs, a detailed description cannot be given at this time. Looking at it through the shell of the host it appears oval in shape and the segmentation is very indistinct. As the larva grows the body contents become plainly visible.

Length of Stage—The length of the larval stage varies with the climatic conditions. Although during the summer the growth is very rapid and the stage may be passed in from five to seven days, it may range from ten to fifteen days. In one case a larva shortly after hatching measured .12 mm. in length and nine hours later it measured almost .6 mm. The growth of the larva occurs practically altogether during the day time.

Feeding of the Larva—Just how the food enters the larva has not been determined, but after it gets within the body it is constantly churned back and forth by contractions of the body. These contrac-

tions may start from either end of the body and move to the other end. There are about three contractions starting from the anterior end to two from the posterior end and there are about two contractions per minute.

The Adult Parasite

Emergence—In emerging the parasite cuts a zigzag opening, by rasping and tearing with the mandibles, around three fourths of the anterior end of the egg. Then by pushing with the abdomen and legs the cap is pushed back with the head. The head is thus forced out and the parasite feels around with its antennæ. Then by continually working the legs within the shell and by extending its abdomen back to the posterior end of the shell it finally gets the front legs free. Then by pulling with the front legs and pushing as before it gradually works the rest of the body free from the shell. The time of day when emergence occurs varies with the temperature. During the spring when the temperature at night fell below 50° or 60° F., the emergence occurred between 9.00 a. m. and 9.00 p. m. From June 2 until September 8 when the temperature at night was above 55° or 60° F. the emergence occurred for the most part between 9.00 p. m. and 9.00 a. m. From September 8 on with temperature conditions the same as in the spring the emergence occurred during the day.

Relation and Economy of Sexes—In a number of experiments conducted to determine the relation and economy of sexes it was found that where a male is supplied to each female a higher percentage of parasitism was obtained. It was also found that a greater number of parasites reached maturity under these conditions. Table I gives the results of these experiments:

TABLE I.—SHOWING THE RELATION AND ECONOMY OF THE SEXES

No. of Trials	No. of Females	No. of Males	Ave. per cent of eggs Parasitized	Ave. per cent. of Mortality of Parasites	Ave. No. Eggs Parasitized per Female
9	2	2	53.4	27.	5.9
10	1	1	51.2	23.4	6.2
9	2	1	52.6	39.2	4.7
8	3	1	26.1	38.9	1.9
1	4	1	12.5	100.	.5
1	5	1	7.5	33.3	.4
4	1	2	37.3	25.3	6.
1	1	3	25.	50.	2.

Number of Eggs—It was not possible to determine with any degree of accuracy the number of eggs a female could deposit. Nineteen individual females parasitized an average of 6.2 eggs; seventy-six females of the first generation parasitized an average of 4.1 eggs; sixty-three females of the second generation parasitized an average

of 3.7 eggs; thirty-one females of the third generation parasitized an average of 3.7 eggs. The largest number of eggs parasitized by a single female was 13.

Twenty-nine females, that had not been allowed to oviposit, were dissected and the number of eggs in the ovaries counted. The smallest number of eggs found was 13, and the largest 29, while the average was 22.8.

PROPORTION OF SEXES—The number of females greatly exceeds the number of males both in the field and in the laboratory. Of fifty-one parasites collected in the field, forty-seven were females, and of the 786 parasites bred out in the laboratory, 512 were females. The number of females bred out in the laboratory is low because of several cases of parthenogenesis in which case the parasites obtained were all males. On an average about 70 to 75 per cent of the parasites obtained in the laboratory were females.

PARTHENOGENESIS—This insect can breed parthenogenetically, but the number of eggs parasitized per female was usually low, and many of the offspring failed to develop. Fifteen trials were made with unfertilized females, and in four cases no oviposition was noticed. Of the 120 eggs parasitized by unfertilized females 50 failed to reach maturity. Seventy parasites were bred out and 66 of them were males.

HABITS IN THE FIELD—The short existence of the adult is occupied in constant activity during the day in hunting for mates, and ovipositing. Feeding, if any, requires a very short time, and the main part of the insect's life is directed towards reproduction. In the wheat fields the parasites were always moving about on the plants near and below the surface of the ground. Unless disturbed, the adults seldom take to the wing. Generally only one parasite was found at a time, but occasionally two or more were found in a very small area. Although it seems probable that they spend their lives in comparatively limited areas, they also distribute themselves to a greater extent than might be expected. It is probable that the wind aids greatly in this.

FOOD—The parasites were never observed to feed in the field, but in the laboratory they fed readily on the sweetened water supplied them.

FLIGHT—The flight of this insect is by short jerky flights. Just how far they may fly at one time has not been determined. They have been observed to fly from a leaf of corn five feet from the ground, but from here the flight could not be followed. In the laboratory the flights were generally short, covering only a foot or two.

EFFECT OF OVIPOSITION IN DIFFERENT STAGES OF THE EGG—The parasites seem to prefer those eggs in which the chinch bug embryo

had not yet begun to show the reddish color. In several experiments in which parasites were introduced to red eggs, there was only one case where the parasite developed and destroyed the embryo. Of the eggs collected in the field, only four red eggs were found that later gave up parasites.

HOST RELATIONS—In all of the experiments, the chinch bug egg was the only one in which this parasite would oviposit. A number of experiments were conducted in which parasites were given eggs of false chinch bugs, and other hemipterous eggs, but no parasitism occurred.

LENGTH OF ADULT LIFE—Owing to the fact that the adults were kept in small vials and without food, there is little doubt but that the length of life was greatly shortened. The length of life varies greatly, ranging from a few hours to twenty-five days. Temperature has much to do with the length of the adult life.. During the spring the adults live on an average of about 93 hours. From June 9th to September 1st the average was from 40 to 60 hours, and after September 1st the average was considerably over 100 hours, in some cases reaching 350 hours.

Food also plays a large part in the length of life, and the more often the parasites are fed the greater the length of life. Table II shows the results of feeding parasites.

TABLE II.—SHOWING EFFECT OF FOOD ON THE LIFE OF THE FEMALE

Fed			Check	
No. of Parasites	Times fed	Av. Length of Life	No. of Parasites	Av. Length of Life
3	1	74 hours	4	33.4 hours
2	2	75½ "	3	54.3 "
3	3	115 "	4	54.2 "
5	9	264 "	7	102.8 "
1	12	414 "	3	152.3 "

LENGTH OF LIFE CYCLE

The length of the life cycle was found to vary with the temperature. The average time between the collection of chinch bug eggs and the emergence of the parasites in May and June was 13.9 days for 81 individuals.

The average length of the life cycle for the second generation was 14.3 days; for the third generation 11.9 days and for the fourth generation 9.9 days. Owing to the scarcity of chinch bug eggs at this time, it was impossible to continue the brood study for about two weeks. From the last of July to the first of September 249 parasites were bred from eggs collected in the field, and the average time between collec-

tion and emergence was 9.8 days. The average length of the life cycle for the sixth generation was 15.2 days; for the seventh generation 17.6 days, and for the eighth generation 27.8 days. Table III gives the brood study.

TABLE III.—SHOWING THE AVERAGE LENGTH OF THE LIFE CYCLE

Brood	Source of Material	Date	No. Parasites	Av. Length Life Cycle
1	Eggs collected in field	4 28–5 27	81	13.9 days
2	From 1st brood	5 20–6 24	61	14.3 "
3	From 2d brood	6 5–6 13	45	11.9 "
4	From 3d brood	6 20–6 24	8	9.9 "
5	Eggs collected in field	7 19–9 6	249	9.8 "
6	From 5th brood	7 28–9 3	157	15.2 "
7	From 6th brood	8 16–9 7	106	17.6 "
8	From 7th brood	9 1–9 14	55	27.8 "

First Appearance in Spring—Inasmuch as the first parasitized chinch bug eggs were found on April 28, it is certain that the parasites were out before this date. The first chinch bug eggs were found in the field on April 24.

Last Appearance in Fall—The last parasite observed in the field this fall was on October 14. A parasite was bred out from a clump of crab grass that had been brought into a warm room on November 6, but the probability is that it was hibernating as a pupa in a chinch bug egg.

Number of Generations—The exact number of generations has not been worked out, but there are about nine or ten. From May 19 to July 5 there was obtained four generations of adults in the life history work. At this time the chinch bug eggs became very scarce, as it was the interval between broods, and thus it was not possible to carry on the life history again until July 23. From then on until October there was obtained four more generations. The interval during which the life history work was forced to be dropped was about two weeks, or almost the length of the life cycle, so that it would appear that there might easily be nine generations a year.

Distribution

This parasite was first discovered during the spring in chinch bug eggs collected in a wheat field near Manhattan. During the summer it was found in every grain field around Manhattan, and, in fact, every place where chinch bug eggs were found. In August a hasty survey of the state was made, and parasites were found in the following counties: Ellis, Ford, Kiowa, Ellsworth, Kingman, McPherson, Harvey, Sumner, Cowley, Riley, Pottawatomie, Montgomery, Allen,

Atchison, Leavenworth and Cherokee. In fact, parasites were found wherever material was collected, and the area given includes practically all of the chinch bug infested region in the State.

Percentage of Parasitism in Different Localities

The average percentage of parasitism of chinch bug eggs collected from various parts of the State outside of Manhattan was 16 per cent. Table IV shows the record of the collection of eggs and the per cent of parasitism.

TABLE IV.—SHOWING PERCENTAGE OF PARASITISM IN VARIOUS PARTS OF THE STATE[1]

Place Collected	Date	No. of Eggs Collected	Per cent Parasitized
Crawford	May 27	116	16.3
Pottawatomie Co.	Aug. 5	55	30.9
Dodge City	" 16	85	18.8
Effingham	" 18	130	15.4
Winfield	" 19	211	24.1
Columbus	" 19	72	12.5
Iola	" 20	79	15.2
Independence	" 21	59	15.2
Hays	" 23	17	17.6
Newton	" 25	47	14.9
McPherson	" 27	14	14.3
Conway Springs	Sept. 3	178	3.9
Kingman	" 4	111	7.2
Greensburg	" 5	5	20.

At Manhattan the average percentage of parasitism for the summer was 32.1 per cent. The greatest number of parasitized eggs were found in the corn field both on the corn plants, and in the crab grass.

TABLE V.—SHOWING PERCENTAGE OF PARASITISM OF CHINCH BUG EGGS AT MANHATTAN, 1913

Month	Total No. Chinch Bug Eggs	Per cent. of Eggs Parasitized
April	309	33.8
May	2232	19.
June	572	22.9
July	96	40.5
August	570	38.
September	232	38.7

Chinch bug eggs are often laid in bunches of two or more, and it is interesting to note that the percentage of parasitism is very high in such cases, ranging from 75 to 100 per cent.

Efficiency—The average percentage of parasitism over the state of 16 per cent does not represent the actual number of chinch bug

[1] This percentage of parasitism over the state is much lower than that at Manhattan, because it is based on only one collection of material and this material was often collected at a time when chinch bug eggs were scarce in the fields.

eggs destroyed. The period of oviposition of the chinch bug covers about two months, while the life cycle of the parasite covers a period of only two or three weeks. Thus the eggs of a single female chinch bug are exposed to about three broods of parasites, while the eggs of one brood of chinch bugs are exposed to four or five broods of parasites. Therefore, the percentage of parasitism for a brood of chinch bugs is at least 50 per cent. Experiments conducted in the field and in the laboratory show this to be true.

President P. J. Parrott: The next paper on the program is entitled "Parasites of the San José Scale in New York—Species and Distribution," by H. E. Hodgkiss and P. J. Parrott.

THE PARASITES OF THE SAN JOSÉ SCALE IN NEW YORK

By H. E. Hodgkiss and P. J. Parrott

(*Abstract*)

Parasites of the San José Scale were numerous during 1913 in New York. To determine the range and species of these insects, infested wood was collected from unsprayed trees in the more important fruit districts of the State. This was obtained from twenty towns representing thirteen counties. From the material we reared the following species,—*Prospaltella perniciosi* Tower, *Aphelinus fuscipennis* Howard, *Aphelinus diaspidis* Howard, *Signiphora nigrita* Ashmead, and *Perissopterus pulchellus* Howard. The last two species mentioned appear to be of comparative unimportance. Taking the state as a whole our breeding records for September and October 1913, indicate that *perniciosi* was probably the most numerous species during that period. *Diaspidis* was numerically greater in two counties while *fuscipennis* ranked first in three counties. It should also be recorded that a count of nearly 800 parasites collected at random showed that about one-half of the specimens were *perniciosi*, one-third were *diaspidis* while the remainder were *fuscipennis*.

Considerable interest has lately centered on the efficiency of parasites to hold the scale in check. To determine the ratio of parasitism numerical counts were made of the scales after the rearings of the parasites were completed. Some twenty thousand individuals were examined of which about thirty-five hundred contained exit holes of the hymenopterons. The percentage of scales affected was variable and on the average ranged between 12 per cent and 24 per cent for the entire state. Locally the range was greater and the tabulations based on wood collected at Geneva showed a difference of from 0 to

35 per cent. This variation in the percentages of scales attacked occurred on individual trees as well as on limbs or smaller branches of the same tree. Of two samples of wood taken from the same branch, one gave no external evidence of the work of the insects while on the other 10 per cent of the scales were parasitized.

In our studies some attention was also directed to the occurrence of parasites in orchards which have been regularly sprayed with the lime-sulphur solution. It is of interest to note that in some instances 12 per cent of the scales were destroyed by the hymenopterons. An examination of fifty large collections of wood from two orchards that have been treated with the above spray for a number of years gave an average of 7 per cent of parasites for each planting.

Interesting as are these statistical accounts it is perhaps hardly necessary to urge the danger of attaching positive values to the above figures. It is apparent from our studies at the present time that the parasites vary a good deal locally both in numbers and in the relative importance of the different species.

A member: It might be interesting to note in this connection that San José scale is sometimes controlled by fungus disease particularly during the wet weather.

MR. E. P. FELT: I would like to ask Doctor Howard whether he has any information as to the possible value of these parasites for controlling San José scale in the future?

MR. L. O. HOWARD: It is guess work. I am quite positive, however, that newspaper advertising of the parasite work on the San José scale is going to hurt the fruit-growing industry, because it will result in many people giving up spraying. We do not know the intimate relationships of the different species of parasites of this insect and considerable study will be required before this information can be secured. We used to think that when a parasite emerged from a scale insect it was responsible for the death of the scale, but this is not always true because the species concerned may be a secondary parasite.

MR. W. E. RUMSEY: I was much interested in President Parrott's paper. During this season in West Virginia I found several orchards where the scales were more thoroughly parasitized than any I have ever seen before.

MR. H. T. FERNALD: I have been watching the parasites of the San José scale in Massachusetts for eight years and their numbers have been discouragingly small during that time. In the fall of 1912, however, quite a large number of parasitized scales was found and

suspecting that something unusual might be going on I had one of my students make collections and from these he bred out two species of parasites in proportions of perhaps 98 per cent and 2 per cent. In these collections about 80 per cent of the scales were parasitized. The parasites which emerged in such large numbers were sent to Doctor Howard who reported that they were a new species and the original description was accordingly published in the *Annals of the Entomological Society of America* for March, 1913, by Mr. D. G. Tower. As a result of the observations which have been made, we find that during the past fall in some localities 90 per cent of the scales are parasitized. It seems to me that we are in a position of the bacteriologist who is able to furnish pure cultures and I am ready to make a proposal in spite of what Doctor Howard has said, to the effect that we will send a few parasitized twigs to any entomologist who is interested in the matter. I agree with Doctor Wheeler that if 90 per cent of the scales are parasitized, the remaining 10 per cent will, nevertheless, furnish an abundant supply for reproduction. If the percentage of parasitism increases as it has in the past two years the results ought to be helpful. Our best results have been secured from collections made from unsprayed trees such as Cornus and Salix.

MR. A. C. LEWIS: I have only seen one or two cases in Georgia where the fungus disease did any particular good in destroying the San José scale. I do not think it can be depended upon as remedy in this state.

PRESIDENT P. J. PARROTT: The next paper will be presented by Mr. V. E. Shelford.

THE IMPORTANCE OF THE MEASURE OF EVAPORATION IN ECONOMIC STUDIES OF INSECTS

By VICTOR E. SHELFORD

The economic importance of any environmental factor is determined by the character of its influence upon organisms of economic importance. Environmental factors influence organisms chiefly in one of three ways: (a) by stimulating migrating animals and causing them to turn back, (b) by producing death, (c) by modifying rate of metabolism, fecundity, length of life, size, etc. Recently attention of entomologists has turned to the study of optimum conditions for insect growth and rate of insect metabolism (Hennings[1], Sanderson[2], Headlee[3]). In these studies the chief criterion of increased meta-

[1] Zeit Land und Forst-Wirt, 5 jrg (a) p. 68.

[2] Jour. Econ. Ent., III, p. 113.

[3] Science, N. S., XXXVI, p. 310.

bolism has been the decrease in the length of the instars. Other indices of rate of metabolism in common use are: (a) the amount of carbon dioxide produced, (b) amount of oxygen consumed, (c) heat produced by the organism, (d) for aquatic animals susceptibility to weak cyanide has been shown to be an excellent method (Child[4]). Those organisms and parts which have the highest rate of metabolism go to pieces quickest. This method gives results exactly similar to that of the measure of the carbon dioxide with which it has been compared. Another method consists in measuring (*e*) the vigor of the behavior reaction (Allee[5]) which has been found to compare favorably with the cyanide results and measure of carbon dioxide. Thus animals with a high rate of metabolism are more sensitive to stimuli and react more vigorously than animals with a low rate. The study of reactions to measured physical factors can no doubt be used to advantage in the study of conditions affecting the organisms.

In a series of experiments the writer[6] has established gradients of evaporating power of air by passing air of three different kinds (rates of evaporation) across the respective thirds of a long narrow cage. These experiments showed that frogs, salamanders, toads, insects and millipedes are sensitive to variations in evaporating power, and turn back when they encounter air of an evaporating power greater or less than their optimum. The experiments also showed that after the animals had been in dry air long enough to have a small amount of water withdrawn, they became more sensitive to the effect of evaporation. The work on insects was not carried far by the writer but additional experiments by E. O. Deere and J. R. Watson support the original results.

In general the reactions were similar for comparable rates of evaporation no matter whether the evaporation was due to *dryness*, *temperature*, or *rate of flow*. Furthermore, death was produced with the same symptoms regardless of the cause of evaporation. There was usually a period of excitation following a short exposure and a period of depression, followed by death. The same disturbances which cause animals to turn back upon encountering air of high evaporating power result in modification of sensitiveness and in death if it is continued and intensified. These three means of influencing organisms are not to be regarded as independent of one another or essentially different because all result from interference with the internal life mechanism. The different results are dependent upon

[4] Roux Archives, XXXV, pp. 598–641.
[5] Jour. Expt. Zoöl., Vol. 13, p. 269–344.
[6] Biological Bulletin, Vol. XXV, p. 79, with good bibliography.

the character of the life mechanism in question and upon the kind and intensity of the stimulation.

Reactions to conditions in experiment, the condition selected and avoided, indicate the conditions suitable for the animals in nature. If such tests are made with reference to sufficient number and combinations of conditions and at a number of periods in the life history, much of a general nature concerning the relations of animals to environmental factors can be determined.

The reasons for the necessity of determining evaporation in connection with the effects of temperature, moisture, wind movement and insolation, may be summarized as follows:

1. The total effect of the air temperature, pressure, relative humidity, and average wind velocity upon a free water surface is expressed by the amount of water evaporated (Hann[1]).

2. The same factors have been shown to determine the amount of evaporation from the bodies of organisms (Reinhard[2]).

3. Metabolism results in heat and the temperatures of the bodies of animals both warm and cold blooded, is nearly always higher than the surrounding medium, at least during activity[3]. The surrounding conditions may be stated as usually acting on metabolism, etc., as follows: (a) A moist cold atmosphere (very low evaporation) causes body temperature to fall more rapidly than a dry cold one at the same temperature, because of the more rapid conduction of heat. Such a fall in temperature *decreases* metabolism of *cold blooded* animals, and *increases* metabolism of *warm blooded* animals within their capacity for heat regulation. In a dry cold atmosphere the heat loss is less pronounced because of the less rapid conduction of heat.[4] (b) In a dry warm atmosphere (high evaporation) rapid evaporation keeps down the peripheral temperature, and prevents death from overheating and destructive metabolism in cold blooded animals, and makes possible body temperature regulation and thus prevents heat stroke and death in warm blooded animals. In a moist warm atmosphere, death and heat stroke occur because of lack of evaporation and lack of peripheral cooling in the case of warm blooded animals even when the surrounding temperature is at or below the normal body temperature.[5] (c) Wind movement (which increases evaporation) increases radiation of body heat and of heat due to insolation[5]. It increases evaporation and further cools the body, thus within

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[1] Climatology, p. 72.
[2] Zeit für Biol., Bd. 5, p. 28.
[3] Schaeffer's Physiology, Vol. I, p. 793.
[4] Hill's "Recent Advances in Physiology and Biochemistry" ('06), p. 256.
[5] Hill's "Recent Advances in Physiology and Biochemistry" ('06), p. 256.

certain limits increasing the metabolism of warm blooded animals and decreasing it in cold blooded animals. (d) Decrease of pressure increases evaporation and radiation both of which lower the temperature of animal bodies and influence metabolism, as stated under (c).

4. Conditions which withdraw water from organisms (evaporation as influenced by various factors) influence irritability, activity and length of life history. Thus Hennings found that low humidity increased insect metabolism and Sanderson found that in dry air the optimum temperature of the growth of insects was lower than in moist air. Thus there are no doubt many exceptions to the usual rules as given under 3. Factors probably operate with reference to an optimum.

From the summary we have noted that water withdrawal is important in itself in many ways. Temperature is a much studied factor chiefly because of the ease with which it is measured in experiments with land animals, changes in temperature are always also changes in the rate of evaporation. Evaporation is best measured with the Livingston porous cup atmometers supplied by the *Plant World*, Tucson, Arizona, and which have proved themselves superior and are now essentially the standard instrument. Table I shows, as measured by these cups, the effect of raising temperature, on humidity and evaporation. The latter is nearly doubled by a rise of 16° C. such as takes place during a few hours of the usual summer day.

TABLE I.—SHOWING THE EFFECT OF RAISING THE TEMPERATURE UPON HUMIDITY AND EVAPORATION UNDER EXPERIMENTAL CONDITIONS. AIR PUMPED FROM A DRY GREEN HOUSE. VELOCITY OF FLOW OVER THE ATMOMETERS ABOUT .104 METER PER SEC. OR 0.2 MILE PER HOUR.[1]

Unwarmed Air			The Same Air Warmed			
Temperature in Degrees Cent.	Humidity in Per Cent of Saturation.	Evaporation in cc. per Hour	Temperature in Degrees Cent.	Temperature Increase	Relative Humidity in Per Cent. of Saturation	Evaporation in cc. per Hour
19	37	1.4	30.0	11.0	17	2.0
14.5	38	1.5	25.5	11.0	19	2.3
22.6	37	1.6	27.5	5.0	25	2.3
22.6	37	1.6	32.6	10.1	18	2.7
22.0	32	1.6	38.0	16.0	14	3.1

[1] The atmometers were inclosed in inverted glass jars by means of large corks. The air was forced against the bottoms of the inverted jars from glass tubes just above and a little to one side of the apices of the atmometers and passed over the atmometers and out through an opening 2 inches below the effective portion of the porous cup. Thus the atmometers were not symmetrically exposed, which is usually the case in outdoor exposures. However the three atmometers used gave the same results for the same humidities and rates of movement. Symmetrical exposure should be attained by use of special glass vessels.

What is still more important is rate of flow, the effect of which is given in Table II, where we note that for very low rates such as are

TABLE II.—SHOWING THE RELATION OF EVAPORATION TO THE RATE OF FLOW AND TO RELATIVE HUMIDITY UNDER THE EXPERIMENTAL CONDITIONS, TOGETHER WITH THE RELATIVE RATE OF INCREASE OF EVAPORATION AND VELOCITY. (0.52 METER PER SEC. EQUALS 1.1 MILES PER HOUR, 0.68 EQUALS 1.5; 0.10 EQUALS 0.2). THE EQUIPMENT IS NOT ACCURATE ENOUGH TO MAKE THIS MORE THAN A GENERAL GUIDE. PRESSURE WAS NOT READ.

Approximate Velocity in Meters per Sec.	Approximate Evaporation in cc. per Hour	Temperature in Degrees C.	Relative Humidity in Per Cent. of Saturation	Ratios	
				Increase in Flow	Increase in Evaporation
.012	.25	22.4	50	1	1.0
.026	.40	22.2	53	2	1.6
.052	.75	22.2	53	4	3.0
.104	1.50	22.2	53	8	6.0
.208	2.00	22.2	54	16	8.0
.416	2.60	22.2	53	32	10.4

used for ventilating cages, *e.g.*, 0.026 meter per sec. gives .40 evaporation, while 0.052 meter per sec. gives .75, nearly double the evaporation at average humidity and room temperature. Evaporation should accordingly be measured, not only on account of its importance in connection with measured temperature and humidity, but also on account of the fact that rate of air movement is not otherwise measurable in terms which have bearing on the life processes of organisms.

MR. A. F. BURGESS: The conclusion given by Mr. Shelford in regard to the effect of moisture on the length of life of insects has proved true in many experiments which we have carried on at the Gipsy Moth Laboratory. In shipping live beetles from Europe and Japan, high mortality is usually caused by the drying out of the packing material. In cases where the packing material is moist on arrival the mortality is always low. The same principle applies in handling breeding jars.

MR. L. M. PEAIRS: Have you tables or other means of telling how much of the results secured were due to chemical action?

MR. V. E. SHELFORD: I have not attempted to determine that, and I do not mean by advocating the use of the atmometer that all these things can be determined, but this is the best means of getting at the total effect of all these agencies.

MR. C. GORDON HEWITT: It seems to me that unless Professor Shelford in his great ingenuity devises some machine to determine the amount of evaporation, which is due to the activity and metabolism of the insects, these studies will not lead us very far. We are dealing with only one of quite a number of factors.

Adjournment.

Proceedings of the Twelfth Annual Meeting of the American Association of Official Horticultural Inspectors

(Papers Continued)

QUARANTINE AGAINST THE MEXICAN COTTON BOLL WEEVIL

By W. D. Hunter

Compared with certain other pests the boll weevil has attracted little attention at the hands of legislators. It is likely that the Phylloxera in Europe and the San José scale in this country have been the cause of many times the amount of legislation that has been enacted against the weevil. Nevertheless, the restrictions that have been directed against it are numerous considering the time that it has been an important factor in the cotton industry and the inherent difficulties in formulating logical quarantines. As it is, every state in the cotton belt has enactments on its statute books which are aimed at the restriction of the spread of the weevil. One territory has similar legislation. The federal government has considered it in a statute and in regulations of the Post Office Department and several foreign governments have edicts against it.

The basis for all the quarantines against the boll weevil in the United States is that it has been spreading rapidly into new territory, and that its life history is such that certain commodities would be very likely to carry it. The natural limitation on all legal restrictions has been that the insect spreads by flight. This dispersion, however, is very limited compared to that of insects like locusts and others that fly over enormous distances. The usual annual advance of the weevil has been only about fifty miles. It is therefore apparently perfectly feasible to prevent spread which might take place in farm commodities over territory considerably more extensive than that which would become infested by the normal flight.

The specific points in the life history of the weevil which seem to justify quarantines in addition to those mentioned need to be noted in this connection. In the cotton-picking season large numbers of adult weevils are crawling about the cotton plants—frequently over the bolls and the exposed lint. Many of these specimens are naturally taken along with the seed cotton by the pickers. They go into the sacks, then into the wagons, and later to the gins. Here it has been found that many of the weevils escape destruction in the process of ginning. It is true that a certain number are killed by the saws of the gin and

modern cleaner feeders kill many more. The number of such feeders in actual use in the country is comparatively small, so that the escape of weevils from the gin must be considered important. In addition to the adult weevils that may be taken to the gin in the manner described, many of immature stages may be so transported. In fact these stages are considerably more important in connection with carriage in cotton products than the adults. It is not rare that the weevil larvæ, pupæ and teneral adults are found within the seeds themselves occupying the space originally taken by the kernel which has been devoured. All of the weevils of this class undoubtedly pass through the gins without injury. There are, moreover, two additional classes of immature weevils which occur in the cotton as it is picked in fields. One of these consists of pupæ imbedded in masses of lint. They form a definite cell which is very similar to cotton seed, although somewhat larger. These cells readily pass through the gins. The other class of weevils to be considered in this connection is contained in very small bolls. In the fall when the infestation in the fields becomes heavy it frequently happens that bolls of very small size are attacked. In many cases their contents are barely sufficient to support a weevil during its immature stages. Under such circumstances the carpel of the boll forms a perfect protection for the insect, in fact, a more thorough protection than the cells formed by the lint or by the shell of the seed itself. These bolls, therefore, carry many weevils through the process of ginning.

After the weevils have passed through the gins they are forced with the seed into the seed houses or sometimes directly into the cars. Examinations of seed being discharged by the blowers has frequently shown the presence of the insects. In a mass of seed the shelter for the weevil is almost perfect. In fact, their chances of passing the winter are nearly equal to those under the most favorable conditions in the fields. The weevil may remain in hibernation from October to June. If specimens happen to be located in seed an excellent opportunity for transportation over long distances is given. It would be perfectly easy for specimens to be taken from the United States to remote parts of the world in this way. A lot of infested seed shipped from Galveston any time during the fall would reach Egypt at the proper season to enable emerging weevils to attack the cotton there which is planted in the month of February. The planting season in India runs from June to August, depending upon the latitude and this would not interfere seriously with the introduction of the insect in that country.

In the United States the first quarantine restrictions were inaugurated in 1903,—the state of Georgia being the first to take such action. At that time apparently little was known about the habits of the weevils and the commodities in which they would be likely to be trans-

ported. This lack of definite information naturally led to enactments that were unnecessarily stringent. The legislators naturally desired to be on the safe side and therefore included many articles in the quarantine which experience has shown are not at all dangerous. Originally hay, oats, and other general farm products were quarantined against. In order to obviate very serious interferences with the marketing of Texas products it became necessary for the Bureau of Entomology in 1903 and 1904 to evolve a system of certifying shipments which originated outside of the territory infested by the weevil. In this way the disturbance caused by the broad quarantine measures that were enacted originally was relieved to the extent of several thousands of carloads of farm products which were certified by the Bureau of Entomology.

At the present time there are two types of quarantines against the boll weevil; one established by specific laws and the other formulated by boards under general authority. There is no doubt whatever as to the relative value of the different types. The first is very unsatisfactory on account of its inflexibility. There is no way short of legislative action to modify the quarantine in such respects as may become necessary on account of new information about the weevil; the other arrangement consisting of the delegation of general authority to boards makes it possible to change the list of articles to be quarantined and the territory against which it is directed as events change from year to year.

The following is a summary of the quarantine restrictions in the several states:

Alabama

The following are the restricted articles in this state.

Seed cotton; cotton seed; seed cotton sacks, cotton seed sacks and cotton pickers' sacks, any of which have been used within eight months for any of the purposes indicated. Cotton seed hulls between August 1 and December 31. Spanish moss and corn in shuck between October 1 and June 30. Living weevils or weevil stages or weevil work in possession of any person outside of the infested territory except a qualified entomologist. Household goods containing any of the foregoing during the period of quarantine applying to each.

The articles not restricted are as follows:

Baled cotton, flat or compressed; linters and loose cotton lint; cotton seed meal, cake and oil; corn shelled or in the ear with shuck removed, oats or any other seed except cotton seed; cotton seed shown by affidavit to have been sacked continuously for nine months or more; cotton seed for planting purposes after fumigation with carbon bisulphid by a competent entomologist; hay; empty freight cars.

California

In this state the boll weevil quarantine is in the form of an order issued by the state commissioner of agriculture on April 23, 1908. It provides that all cotton seed shipped into the state shall be consigned to one of the deputy commissioners of horticulture who is required to fumigate with carbon bisulphid.

Florida

The restrictions in effect are authorized by a general statute against pests which was passed in 1911. Special rules regarding the boll weevil were published in June, 1912.

The restricted articles are as follows:

Seed cotton; cotton seed; seed cotton sacks, cotton seed sacks and cotton pickers' sacks, any of which have been used within eight months for any of the purposes indicated; cotton seed hulls between August 1 and December 31; Spanish moss and corn in shuck between October 1 and June 30. Living weevils or weevil stages or weevil work in possession of any person outside of infested territory except a qualified entomologist. Household goods containing any of the foregoing during the period of prohibition applying to each. Sugar cane when not cut back and stripped of its leaves.

The articles not restricted are as follows:

Baled cotton, flat or compressed; linters and loose cotton lint; cotton seed meal, cake or oil; corn shelled or in the ear with shuck removed, oats or any other seed except cotton seed; cotton seed shown by affidavit to have been sacked continuously for nine months or more; cotton seed for planting purposes after fumigation with carbon bisulphid by a competent entomologist; hay; empty freight cars; sugar cane when cut back and stripped of its leaves.

Georgia

The law of August 15, 1904, was amended August 23, 1905. The regulations have been revised several times, last in October, 1913.

The restricted articles are as follows:

Seed cotton; cotton seed; seed cotton sacks, cotton seed sacks, cotton pickers' sacks which have been used within eight months; cotton seed hulls between August 1 and December 30; Spanish moss and corn in shuck or shucks removed from corn between October 1 and June 30; household goods containing any of the foregoing during the period of quarantine applying to each; living weevils in the possession of any person outside of the infested territory except a qualified entomologist and his certificate accompanying same.

The unrestricted articles are as follows:

Bales of cotton, flat or compressed, with no restrictions as to season;

linters and loose cotton lint; cotton seed meal, cake and oil; corn shelled or shucked or with shucks removed, oats or any other seed except cotton seed; cotton seed shown by affidavit to have been sacked continuously for nine months or more; cotton seed for planting purposes only, after fumigation with carbon bisulphid by a competent entomologist; hay; empty freight cars.

Louisiana

The state entomologist of Louisiana is authorized to promulgate such quarantines as may seem advisable. Since the entire state is infested at the present time no regulations are in effect.

Mississippi

In this state there is an absolute quarantine against seed cotton, cotton seed hulls, sacks, and other articles. Baled cotton can be shipped into the uninfested parts of the state only in tightly inclosed cars.

North Carolina

The quarantine in this state in its present form was promulgated in June, 1910. It prohibits the bringing into North Carolina of all seed cotton or cotton seed hulls originating in any infested territory. Shipments of baled cotton are allowed only in hard compressed bales. If shipped in any other way it is declared to be a public nuisance and liable to seizure.

Oklahoma

The rules and regulations established by the state entomologist cover the usual cotton products, also provide that baled cotton can be shipped only in tightly closed box cars. The prohibition against the use of the quarantined articles, as bedding or feed for live stock in transit and as parts of general shipments consisting of household goods, is included.

South Carolina

The articles restricted are as follows:

Cotton seed and seed cotton for any purpose whatsoever are prohibited; seed cotton sacks, and cotton pickers' sacks, any of which have been used within eight months for any of the purposes indicated, are prohibited; cotton seed hulls are prohibited between August 1 and December 31; Spanish moss and corn in shuck are prohibited between October 1 and June 30; living weevils or weevil stages, or weevil work in possession of any person outside of the infested territory, except a qualified entomologist, are prohibited; household goods containing any of the foregoing are prohibited during the period of quarantine applying to each.

The articles not restricted are as follows:

Baled cotton, flat or compressed; linters and loose cotton lint; cotton seed meal, cake or oil; corn shelled or in the ear, with shuck removed, oats or any other seed except cotton seed; hay; empty freight cars.

Tennessee

The articles restricted are as follows:

Seed cotton; cotton seed; seed cotton sacks, cotton seed sacks; cotton pickers' sacks, any of which have been used within eight months for any of the purposes indicated; cotton seed hulls between August 1 and December 31; Spanish moss and corn in shuck between October 1 and June 30; living weevil stages or weevil work in possession of any person outside of the infested territory except a qualified entomologist; household goods containing any of the foregoing, during the period of quarantine applied to each.

The unrestricted articles are as follows:

Baled cotton, flat or compressed; linters and loose cotton lint; cotton seed meal, cake and oil; corn shelled or in the ear, with shuck removed, oats or any other seed except cotton seed; cotton seed shown by affidavit to have been sacked continuously for nine months or more; cotton seed for planting purposes after fumigation with carbon dioxide by a competent entomologist; hay, empty freight cars.

Texas

A rule of the commissioner of agriculture makes it illegal to ship seed cotton or cotton seed, or any other articles which might carry the boll weevil from an infested to an uninfested county.

Value of Quarantines

The most definite statement regarding the practical value of boll weevil quarantines in the literature was made by Mr. W. Newell as follows:

"Prior to the enforcement of quarantine regulations by the State Crop Pest Commission, many cases of isolated infestation occurred in the western parishes of the state, most of them being directly traceable to the bringing of seed cotton or cotton seed from the infested sections of Texas. Since the commission's quarantine regulations, which prohibit the movement of seed cotton, hulls and cotton seed from the infested to the non-infested sections, have been in force not a single isolated outbreak of the boll weevil has been discovered and all of the northeastern and eastern portion of the state is, fortunately, still free from this pest. By means of this quarantine artificial dissemination of the weevil in Louisiana has been practically an impossibility and the spread of the pest into new territory has been limited

to actual flight; had it not been for the protection this afforded eastern Louisiana there is little doubt that the most of Louisiana's cotton-producing territory would now be infested, instead of the pest being confined entirely to the western parishes." (Circular 9, La. Crop Pest Commission.)

This statement may possibly be somewhat overdrawn, but the writer believes it is substantially correct. At any rate, with one exception (due to intentional introduction) no isolated colonies far beyond the territory reached by flight have ever been discovered. How much of this is due to the legal restrictions that have been described, and how much to accident, cannot be determined with certainty. It seems evident, however, that the possibilities for the spread of the weevil in certain classes of farm products are great. It is, therefore, altogether likely that many introductions have been prevented, and the writer believes the value of the quarantines has far overbalanced the temporary interferences with shipping that they have caused.

NOTES ON ENTOMOLOGICAL INSPECTION IN THE DISTRICT OF COLUMBIA

By E. R. Sasscer

Although there are no laws on the statute books of the District of Columbia governing the inspection of incoming and outgoing plants, every attempt has been made to examine such material. Until the enactment of the Plant Quarantine Act on August 20, 1912, this work was carried on by the Bureaus of Entomology and Plant Industry of the Department of Agriculture, and, subsequent to that date, has been conducted under the supervision of the Federal Horticultural Board. All plants entering or leaving the District of Columbia are inspected both from an entomological and a pathological standpoint.

There are two classes of inspection in the District of Columbia, namely, commercial and departmental. The former consists in the inspection of all imports for florists, department stores, and private individuals, and includes such plants as boxwood, azaleas, rhododendrons, roses, hydrangeas, orchids, etc. Since the first of the current calendar year some 496 cases of plants have been examined.

"Departmental inspection" includes the careful examination of all plants and plant products introduced and distributed by the Office of Foreign Seed and Plant Introduction as well as other offices of the Bureau of Plant Industry. Some 2,000 packages containing various plants and plant products have been examined during 1913. For the accomplishment of this work there has been provided a special quar-

antine house, which is properly equipped with suitable fumigation facilities, and is further provided with a stove, which is used to destroy all condemned stock. This house is sufficiently large to allow the opening of large containers, which may be fumigated without removal, should they contain any suspicious insects. Small packages of seeds, scions, and cuttings are examined in a room which is tightly screened to prevent the exit of very minute insects should they escape from the package at the time of examination. All plants regarded as suspicious are grown under observation in a greenhouse, which is used for this work alone and which is likewise tightly screened with a fine-mesh wire. An accurate record is kept of all plants and plant products introduced by the Office of Foreign Seed and Plant Introduction as regards their origin, destination, nature, quantity, and date of inspection.

Judging from the numbei of packages and boxes examined during the past year, one would naturally suppose that the inspection in the District of Columbia is comparatively light. As regards the number of plants examined, this may be true, but one must not lose sight of the fact that a very large percentage of the plants and seeds introduced by the Office of Foreign Seed and Plant Introduction originate in countries and localities of which we know little as regards their entomological and pathological status. For this reason all packages containing plants and seeds are thoroughly examined by representatives of the Federal Horticultural Board, and anything showing the slightest suspicion is either destroyed or grown under observation in quarantine. It may not be out of place to cite an example of the close inspection required to intercept pests coming in on stock from abroad. Some time ago cuttings taken from a peach tree which was supposed to have considerable value as regards the quality of fruit produced were received from Shantung, China. From a casual examination it appeared that these cuttings were free from injurious insects, but, on close examination, they were found to exhibit over the surface of the bark a few abrasions or scars, which, when opened, were found to contain from eight to ten eggs of a tree hopper. This stock was all destroyed and a second attempt was made to get an uninfested shipment of this material. On examination the second shipment was found to be likewise infested and was also destroyed. As to the amount of injury which this insect is capable of doing in the United States, should it become established, it is impossible to say, but, judging from the experience in the Mississippi Valley some years ago with a tree hopper (*Ceresa bubalus* Fab.), it would be decidedly disadvantageous to allow any insect of this nature to become established in America.

To show the possibilities of a close inspection, another shipment may be referred to which was inspected on May 26, 1913. This consignment consisted of mango plants in a wardian case from Java, and, on superficial examination, would probably appear to be free from injurious insects. These plants, however, were removed from the case, and a thorough examination revealed the presence of the following coccids:

Leucaspis indica Marlatt	*Aspidiotus lataniæ* Sign.
Fiorinia theae Green	*Aspidiotus hederæ* Vall.
Pseudaonidia clavigera Ckll.	*Parlatoria pseudaspidiotus* Lindgr.
Pseudaonidia trilobitiformis (Green)	*Vinsonia stellifera* Westw.
Aspidiotus dictyospermi Morg.	*Lecanium* sp.
Aspidiotus palmæ Morg. &. Ckll.	*Pseudococcus* sp.

Ceroplastes sp.

In addition to the coccids listed, some of the leaves were well covered with galls, resembling, in may respects, those produced by certain coccids on eucalyptus in Australia. Unfortunately, we were unable to detect any female insects in the galls, and, therefore, it was impossible to ascertain the real maker. Mangoes have also been received from India infested with *Phenacaspis dilatata* (Green), *Asterolecanium pustulans* (Ckll.), and an immature *Pulvinaria*.

In addition to the pests referred to, the following have been collected from time to time entering the District of Columbia on imported plants and plant products:

Potatoes (*Solanum* sp.). The Potato weevil (*Rhigopsidius tucumanus* Heller) was found to be infesting potatoes from Peru, Bolivia, and Ancud or San Carlos and Castro Islands, Chile. In addition to the weevil referred to there were also in the potatoes from Peru two species new to science representing also two undescribed genera. When examining these tubers the attention of the inspector was attracted to what appeared to be a dryness of certain parts of the peel, resembling somewhat the work of some leaf-miners in leaves. On opening these dry spots the weevils in question were found. The first shipment, which arrived in the month of May, included not only the adults but the larvæ and pupæ. A subsequent shipment, received on December 4 from Bolivia, exhibited only the adults of *Rhigopsidius tucumanus*. We have recently received from Mr. C. H. T. Townsend, who is located in Peru, information to the effect that occasionally potatoes reach the tables of second rate hotels containing cooked larvæ in their galleries.

Red mangrove (*Heriteria littoralis*). Pods of this plant from the Philippine Islands on examination were found to contain a number of Cryptorhynchid beetles, which, according to the authorities of the National Museum, represent undescribed species.

Mango (*Mangifera indica*). Seeds of this plant have been received from Mauritius, India, and Ceylon infested with the mango weevil. In order to realize the danger of such a pest if established in mango-growing sections, one has only to refer to Press Bulletin No. 17 of the Hawaiian Experiment Station by Mr. D. L. Van Dine. Seeds of mango have also been received from the Philippine Islands infested with a species of *Rhizoglyphus* which appears to be a dangerous pest.

Pistacia vera from Italy revealed a slight infestation with a scale insect known scientifically as *Diaspis gennadi* Leonardi. This is the first record of the appearance of this scale insect in America, and, in fact, is the only reference to this coccid since its description in 1898 on *P. terebinthus* from Greece.

Sugar cane has been received from the Philippine Islands infested with a species of *Odonaspis*. These canes also exhibited work which resembled very much that of representatives of the genus *Xyleborus*. In addition to the insects present, these canes were affected with a fungus, and the entire shipment was burned. A similar shipment of cane was received from Hawaii, and, owing to the fact that these plants originated from a country known to harbor serious enemies of this plant, they were ordered to be grown under supervision in the quarantine house. After some little time it developed that the canes in question were harboring eggs of the destructive leaf-hopper, *Perkinsiella saccharicida* Kirkaldy. The object in making this importation was to introduce into Porto Rico a special variety of sugar cane. Had these cuttings been passed and allowed to go to their intended destination, it would doubtless have resulted in the establishment of the sugar-cane leaf-hopper in this insular possession, eventually meaning great financial loss to the cane growers.

Date palm. A number of shipments of date palms imported from Egypt were found to be infested with the date-palm scales, *Phœnicococcus marlatti* (Ckll.) and *Parlatoria blanchardii* (Targ.). These coccids are of common occurrence on date palms and have been entering this country on these plants for a number of years. It is remarkable how the former species can get down between the various leaf sheaths of the plants in question. In fact, this scale has been found between sheaths that were so tight that they could not be separated without the aid of an ax. Secluding themselves as these coccids do, it is very obvious that it requires a special effort to detect and control pests of this nature.

Avocado. Avocado seeds have been received from Mexico and Costa Rica infested with the avocado weevil (*Heilipus lauri*). Little is known of the life history and habits and the possible injury occasioned by this insect in its native habitat. Badly infested seeds are

well riddled with galleries and rendered worthless. Adults in confinement have been observed feeding on the leaves and later attacking the woody portion of the plant, ultimately resulting in the death of the latter. A number of experiments have been conducted with the idea of determining if it is possible to fumigate infested seeds with safety. Owing to the long period required for germination it is impossible to give definitely as yet the effect of the fumigation on the seed. In so far as the insects are concerned all stages were destroyed. As soon as these experiments are completed a detailed report will be given, stating the method of fumigation and general effect on the insects and seed. In addition to the avocado weevil, seed have also been received from Mexico infested with a Scolytid, which may also prove to be a dangerous pest, should it become established.

Cotton. Seed of wild cotton from northern Transvaal were examined on October 11 and found to be infested with a very interesting bruchid which has not as yet been identified.

Aside from the pests listed, many others, some of which are new to science, have been taken during the course of inspection, but owing to the limited amount of time on hand, it is deemed wise to overlook them for the present.

NEW JERSEY STATE ANTI-MOSQUITO CONVENTION

A significant and interesting convention was held at the Hotel Traymore, Atlantic City, N. J., February 20 and 21, 1914. It was the annual meeting of the County Mosquito Extermination Commissions of the state, and was called to order at 2.30 p. m., Friday, February 20, by the temporary chairman, Dr. Ralph H. Hunt of East Orange. After a brief invocation by Rev. Henry J. Zelley, the mayor's representative extended a hearty welcome to the visiting delegates. Then followed a symposium on "Anti-Mosquito Work in New Jersey—Methods Employed and Results Obtained:" Essex County, Mr. Spencer Miller; Union County, Mr. Louis J. Richards; Hudson County, Mr. William Delaney; Atlantic County, Mr. Harold I. Eaton; Passaic County, Mr. J. S. Davison; Camden County, Dr. William A. Westcott; Cape May County, Mr. Joseph Camp; Bergen County, Mr. H. B. Vannote. These reports were of much interest, describing conditions found and giving the results of work accomplished, several being illustrated by photographs or lantern slides. Concluding the afternoon session was an illustrated address by Dr. T. J. Headlee, entomologist of the New Jersey Experiment Station, on the "Anti-Mosquito Work of the New Jersey Experiment Station." Doctor Headlee

showed the progress of the work and pointed out the marked increase in property values where the salt marshes had been drained.

The evening session was held in the auditorium of the Atlantic City high school where Dr. L. O. Howard, chief of the Bureau of Entomology, gave a very interesting lecture illustrated with lantern slides, on "Important Methods and Results of Anti-Mosquito Work in Various Parts of the World." Doctor Howard showed views in many lands and of particular interest were the portraits of the men who have made the principal discoveries connected with mosquito-borne diseases and with anti-mosquito work—closing by showing the portrait of the late Dr. John B. Smith.

Dr. Jacob G. Lipman, director of the New Jersey Experiment Station, in a brief address on "What Mosquito Extermination Means for New Jersey Agriculture" told of the inexpensive lands in southern New Jersey which had not become inhabited on account of the mosquito scourge.

A representative of His Excellency was present and made a brief address assuring the delegates that the executive department was in sympathy with, and would foster such anti-mosquito work as is now being done, which is clearly for the benefit of the state.

A film of moving pictures showing the development of mosquitoes from egg to adult and the various stages in ditching operations concluded the program for the evening.

The next morning the meeting opened at 9.30, and the first paper "Anti-Mosquito Work in New York State" by Dr. Joseph O'Connell, health officer of the Port of New York, was read by Doctor Headlee as Doctor O'Connell could not be present. In the next paper "Anti-Mosquito Work in Connecticut," Dr. W. E. Britton, state entomologist of Connecticut, explained what has been accomplished in that state, illustrated by lantern slides. This was followed by "Anti-Mosquito Work in Philadelphia," by Mr. Herman Hornig, entomologist of the City of Philadelphia. Mr. Hornig's paper was also illustrated by lantern slides.

Of especial interest was the next subject, "Mosquito Extermination Work from the Standpoint of the Taxpayer," discussed by Mr. A. W. Hamburg, president Newark Board of Trade; Mr. Walter A. Evans, director Essex County Board of Freeholders; and Hon. Carleton B. Pierce, Cranford, N. J.

At the close of the program, the meeting on permanent organization reported in favor of such action and submitted a constitution and by-laws and nominations for officers. The report of this committee was accepted and the following officers were elected for the ensuing year.

President, Dr. Ralph H. Hunt, East Orange, N. J.
First Vice-President, Dr. William Edgar Darnall, Atlantic City, N. J.
Second Vice-President, H. B. Vannote, Hasbrouck Heights, N. J.
Secretary-Treasurer, Thomas J. Headlee, New Brunswick, N. J.

The Executive Committee consists of these officers *ex-officio* and of the following members elected at large:

Mr. W. C. Hope, Roselle, N. J.
Dr. H. H. Brinkerhoff, Jersey City, N. J.
Mr. C. H. Cranmer, Manahawkin, N. J.
Dr. W. A. Westcott, Berlin, N. J.

The County Mosquito Extermination Commissions of New Jersey consist of the county health boards and where such boards do not exist are appointed by the justice of the Supreme Court, to serve without compensation, and the plan has resulted in obtaining men of exceptionally high standing to serve as members.

Considerable work has already been done in Union, Passaic, Essex, Hudson, Atlantic, Cape May, Bergen, and Ocean counties, and it is expected that the commissions in the other counties will soon start into activity. It is planned to publish the proceedings and to hold a similar convention each year.

Arrangements had been made to hold a demonstration of cutting ditches on the salt marsh in the afternoon, but on account of the weather, and as many wished to return to their homes, the plans were abandoned. The convention was a marked success, and the following sentiment was frequently expressed:—"What a pity that Dr. John B. Smith, who was really the father of this work in New Jersey, could not have been spared to be with us on this occasion." W. E. B.

THE GENUS PSEUDOKERMES IN MONTANA

By George B. King, *Lawrence, Mass.*

Pseudokermes cooleyi, n. sp. Adult female scale, four mm. in diameter, subglobose. Stramineous, very shiny, with four jet black irregular transverse bands, not linear, texture of scale thin. Boiled in caustic potash the derm is clear and tinged with yellow. Mouth-parts, very distinct, rostrum monomerous, rostral loop short and stout. The derm is not tessellated, no vestige of legs or antennæ visible, although the derm was clear, and if present could easily be seen. A number of embryo larvæ were present, but the young were not advanced enough to describe.

Hab.—On *Picea englemanni* at Corvallis, Montana, May, 1912. Collected by Prof. R. A. Cooley and I take much pleasure in naming this very interesting species after the collector. This is the third species of *Pseudokermes* to be described. The first was *P. nitens* Ckll. 1895, described from Brazil on *Myrtus* (*Blepharocalyx*) *tweedii* and the second *P. armatum* Ckll. 1899, described from S. Francisco de Peal, Tobasco, Mexico, on *Palo de gusano.*

Professor Cooley has given me the following notes:

"The specimens I sent you were collected on a large *Picea englemanni* on the main street of the little town of Corvallis in the Bitter Root Valley, Ravalli County, Montana. The species Picea is of such wide distribution that this individual tree may have been introduced from a considerable distance or may have been taken from forests near by. I have attempted to trace the history of this particular tree and have failed. The probabilities are that it originated locally and that this *Pseudokermes* is native. The insects were not abundant on the tree."

A NOTE ON SIGISMOND MOKSHETSKY AND HIS WORK IN THE CRIMEA

By L. O. Howard

In my address on the recent progress and present conditions of economic entomology, published in the Proceedings of the Seventh International Zoölogical Congress and also in *Science,* New Series, Volume XXV, pages 769–791, December 6, 1907, I referred to Mokshetsky in the following words:

"Professor Mokshetsky is the Director of the Museum of Natural History in Simferopol, an institution which he has built up by his own labors. He has conducted many investigations in economic entomology, and has published a number of papers of value. Entirely through his influence, the Crimea, a most fertile country in which great attention is devoted to fruit growing, was perhaps the earliest locality in Europe in which American ideas in economic entomology were introduced. It was most interesting to walk, as I did on several occasions, through enormous orchards and see everywhere American spraying machinery and see the crops in as good condition as they could possibly be found in the most up-to-date region in the United States."

There was published nearly a year ago in Simferopol an account of the twenty years *jubilaum* of Mokshetsky, written by Theodore Stcherbakof, from which it appears that in 1912 twenty years of scientific work by this excellent economic entomologist were completed.

Mokshetsky[1] was born May 2, 1865, and was educated in Vilna, later entering the Forest Institute where he attended the entomological lectures of Cholodkowski. He went into steppe forestry work, and afterwards became assistant forester in the management of the government property at Charkow. From 1890 to 1892 he devoted

[1] The name is variously spelled in English, for example as Mocrzecki; but the spelling here used was personally given to the writer by Mokshetsky himself in 1907 as best giving the sound of his spoken name.

himself to entomology in the Zoölogical Laboratory of Charkow University. He went to the Crimea in the spring of 1893. At this time insects were causing great damage, and he was freed from his administrative duties and began to take up direct work in economic entomology. He began immediately the study of *Eurygaster maura* Fabr., which had destroyed twenty-three thousand acres of winter wheat. He worked in the field, studying the insect, and the result of his work was the publication of a report upon this species which is said to have been the first work in Russia by an entomologist who was actually stationed for an extended space of time in the field. He pointed out the necessity of establishing a local entomological laboratory, but since there was no action upon this suggestion by the local or other authorities he conducted a laboratory in his own private house. Three years later the board of the local government gave him two rooms for his insectary and two hundred rubles (about one hundred dollars) a year. This was the beginning of the Zemsky Museum of Natural History. He soon filled his rooms with entomological collections and specimens of the fauna and flora of the Crimea, and, constantly urging the necessity for establishing a competent museum of natural history, he was finally able to make a formal opening in 1899. Since that time he has worked with constantly increasing efficiency and with slowly increasing support. He organized the Crimean Naturalists' Society and Society of Nature Lovers. He was a pioneer in the starting of entomological stations in Russia, and has given courses of lectures on entomology to land proprietors, instructors and agronomists. In recent years he has often gone to the Caucasus where he has helped to organize and conduct courses in entomology for the public school teachers, and has given instruction to practical entomologists, many of whom are now working in many parts of Russia. He is now the chief specialist in practical entomology in the Department of Agriculture. He was the first to introduce into Russia modern American spraying machinery and to adopt the up-to-date methods of American economic entomologists.

Not content with the great work which he has already done, he is now engaged in organizing an experiment station in pomology near Simferopol, which will include branches in entomology, mycology, chemistry and meteorology.

It is astonishing what this energetic fellow-member of our Association of Economic Entomologists has accomplished, beginning single-handed, and by the strength of his own force accomplishing success which attracted the attention and support of the local and Imperial governments. American entomologists I am sure will congratulate him and wish him at least another twenty years of successful work.

SIGISMOND MOKSHETSKY, the Economic Entomologist of the Crimea, his family, his assistants and friends; taken in his garden at Simferopol, May, 1907. Mokshetsky is third from the left, standing; his principal assistant is fifth from the left, standing, while his artist is on the extreme left. The gentleman seated is personally known to most American entomologists.

THE USE OF ATMOMETERS TO MEASURE EVAPORATION IN THE STUDY OF INSECTS

By V. E. Shelford

The porous cup atmometer or evaporimeter, was first designed by Babinet in 1848. Subsequently, it was independently devised by several workers. B. E. Livingston was one of the last of these and his instrument has become the standard in this country and Europe. It consists of a cup of porous baked clay about 5 inches long and 1 inch in diameter. The cup is filled with water and a rubber stopper containing a small glass tube is inserted into the opening. It is placed cork end down and the glass tube is connected with a bottle or other reservoir of water. As water evaporates, the cup remains full and water is withdrawn from the reservoir. The amount withdrawn is the amount of water evaporated. Differences in evaporation are shown corresponding to changes in temperature, air moisture, air movement and air pressure. Black, brown or other colored cups are used to determine the effect of light. In sunlight, the colored cups show a greater amount of evaporation than the white ones. Cups of the color of the insects studied could probably be used to advantage.

The instruments have been found indispensable by numerous persons attempting to study and control the complete environment. They are used both in cages and in the field where they are the only instruments that record the effect of wind movement and exposure to the sun as well as temperature, etc., in terms of any physiological significance. Rain correcting device has already been invented by Livingston. The cups may be obtained from the *Plant World*, Tucson, Ariz., and details as to their use can be obtained from the files of that journal for 1910 and 1911. Reasons for the importance of the measure of evaporation based upon the study of literature, and some experiments are given by the writer elsewhere in the Association's Journal.

Prof. J. H. Comstock, for thirty nine years instructor and professor of entomology at Cornell University, has resigned and will retire from active duties at the close of the present academic year. The following expression of appreciation by the Board of Trustees was made public: "In accepting the foregoing resignation the trustees congratulate Professor Comstock on his long, honorable and fruitful service to Cornell University, with which as student and teacher he has been associated almost without interruption since he matriculated as a freshman, and they bear grateful testimony to his success in teaching and in inspiring students and also in scientific investigation, for the continuance of which they trust his health and energy may be preserved for many years to come to the honor of his alma mater and the advancement of truth and knowledge."

Scientific Notes

Gipsy and Brown-tail Moths. According to *News Letter No. 1*, of the Bureau of Entomology, a small gypsy moth infestation has recently been discovered in a suburb of Cleveland, Ohio, where a few egg-masses were found. The territory has been examined by scouts of the Bureau of Entomology and the Bureau in coöperation with the State Nursery Inspector will attempt to exterminate the colony.

Egg-clusters have been found in several towns in eastern Connecticut during the winter, by scouts of the Bureau of Entomology. The pest has apparently spread into Connecticut from Rhode Island and Massachusetts. No egg-clusters were found at the old infestations (Wallingford and Stonington) by either state or federal scouts. No egg-clusters have been found this winter at Geneva, N. Y., where the pest was discovered more than a year ago.

There has also been a considerable spread of the brown-tail moth toward the South and West. Inspectors of the New York State Department of Agriculture found nests on Fisher's Island, N. Y., a small island off the coast of Stonington, Conn. In Connecticut nests have been found along the coast as far west as the Connecticut River, one nest being found in Saybrook, west of the river. In the northern part of the state one nest was found in Granby and four in Simsbury. These points are several miles west of the Connecticut River. It seems to be only a matter of a few years when all parts of the state will become infested, and the moths will probably soon reach the eastern end of Long Island, if they have not already done so.

W. E. B.

Publications of the Bureau of Entomology. On July 1, 1913, the series of bulletins and circulars of the several bureaus and offices of the Department of Agriculture were discontinued and a general or departmental series to take the place of them was started. The Technical Series of the Bureau of Entomology was also discontinued and such entomological matter of this nature as is to be published by the department hereafter (*i.e.*, technical matter which is the result of original research) will appear in the new *Journal of Agricultural Research.*

The concluding number of the circular series is No. 173; of the bulletin series, No. 127, and of the Technical Series, No. 27. Bulletin No. 123 has just been issued, and Technical Series No. 26 will be issued in a week or so; these two will fill up the gaps in the two series.

As several of the bulletins and Technical Series bulletins which have been issued in parts are still incomplete, the bureau is to be permitted to complete these and this will be done during the next few months. Each of these bulletins, when complete, will consist of at least two parts and will have in addition an index or a Contents-and-Index part. An exception to this rule is Bulletin No. 83, which cannot, under the new plan of publication for the Department, be completed. Part I will be the only part of this bulletin issued, and there will be no index part.

(From *News Letter No. 1, Bureau of Entamology.*)

Notes on Three Imported Insects Occurring In New Jersey. *Aspidiotus* (*Diaspidiotus*) *tsugæ* Marlatt., During the spring of 1910 hemlock imported from Japan was found to be badly infested by the above scale described by Marlatt in *Entomological News* for November, 1911. From the badly infested condition of the trees, it was considered an extremely unwelcome importation. In the report of the state entomologist by Dr. J. B. Smith published in the Proceedings of the thirty-ninth annual meeting of the New Jersey State Board of Agriculture for 1912, Doctor

Smith said: "It may be interesting to note that I believe that the entire infestation in New Jersey has been destroyed and if any specimens do exist they are accidental escapes left on the grounds when all infested plants were supposed to have been destroyed. There was no sale of this stock through the New Jersey nurserymen."

It is equally as interesting to note that in January, 1914, almost four years later, the scale was found in large numbers infesting Japanese hemlock in the same part of the state where it was originally discovered. It can therefore be said to have gained a slight foothold. Apparently some accidental escapes were left on the grounds when all infested plants were supposed to have been destroyed. This shows the need of extremely close supervision in the case of scale infested imported plants. It is unwise to try to pick out the infested plants and allow the apparently clean ones of the shipment to come through, especially when stray scales are likely to be overlooked. One can never be sure that the infestation has been entirely destroyed. An attempt will be made again to wipe this scale out of New Jersey.

Agrilus sinuatus Oliv. The work of this buprestid was first noted in New Jersey in 1894 at which time it did considerable injury to pears in orchards and nurseries in the northern part of the state. According to Bull. 109 of the New Jersey Agric. Exp. Sta. by J. B. Smith it was probably introduced from France. In "Insects of New Jersey" it is listed as being local in Essex, Union and Middlesex Counties, "an introduced species that is being gradually worked out." An additional county can now be added to the list, namely Bergen. While it is true that it is not abundant, every year, it is customary to run across its work in the northern part of the state. In spite of the fact that it is no longer destructive, it is evidently holding its own in a small way and spreading somewhat.

Kaliosysphinga dohrnii Tischbcn. During the summer of 1913 this sawfly leaf miner was first noticed in New Jersey at Elizabeth on European alder, *Alnus glutinosa*, growing in a nursery. The leaves were mined so badly that the trees presented the appearance of having been swept by fire and the ground below was strewn with dried leaves. This insect was first described in Germany in 1846. While mentioned in Smith's "Insects of New Jersey," it is not recorded as occurring in New Jersey. An account of this leaf miner can be found in Bull. 233, Cornell University Agric. Exp. Sta., by M. V. Slingerland.

H. B. Weiss,

New Brunswick, N. J.

A Coleopterous (Clerid) Larva Predaceous On Codling Moth Larvae. This note is to give only a word concerning an enemy of the codling moth larva that is common in this locality. Not having seen reference to this enemy elsewhere, I give the note for the benefit of other workers and that more information may be obtained for myself. Any detailed observations made later here will be announced.

While examining some old bands for the codling moth in an abandoned orchard near Mesilla Park, N. M., October 20, 1912, I found a coleopterous larva in the cocoon of a codling moth larva. The latter was limp, the greater part of its body juices having been sucked out.

The predaceous larva was placed in the laboratory in a glass jar containing some earth and fragments of tissue paper. A half dozen codling moth larvæ were placed in with it. In the spring I thought it had gone into the earth to pupate as I could not see it as I had previously. So it was left until October 17, 1913. On that day the tissue paper was carefully removed and the larva was found snugly curled up in the emptied cocoon of a codling moth larva. The codling moth larvæ had been eaten before pupation. More of the food of this predaceous fellow was put in on this day and it remains thrifty to the present date.

In the last week in December I visited the large apple orchard of Mr. J. G. Stuart, west of Mesilla Park, N. M. His trees were banded for the codling moth. He was well aware of the presence and beneficent work of his "warriors," as he called them, under the bands. On examining several of the bands I collected a number of the larvæ in question along with codling moth larvæ for their food. These were placed in the laboratory in hopes an adult might be reared.

Being in doubt as to the family to which the larva belonged, I sent specimens to Dr. L. O. Howard, Washington, D. C., and to Prof. H. F. Wickham, State University of Iowa, to both of whom I am indebted for their kindness in the matter of identification. Both reported that the larva was evidently that of some species of clerid. Doctor Howard stated that it was "apparently quite common in New Mexico." No specific indentification of the larva was attempted.

It is to be hoped that adults may be reared from the material on hand so the species may be determined. The long larval period of members of this family adds difficulties to this attempt. I have never yet noted adult clerids about the bands.

D. E. Merrill,

The Twig Girdling Habit of Hemerocampa leucostigma by Caged Specimens. J. A. Lintner, in his second report as New York State Entomologist, 1885, pp. 86–89, describes the extensive girdling of elm twigs by this species at Albany, N. Y., in 1883 and states that he observed the same thing at Troy, N. Y., six miles north of Albany. In his eleventh report, 1895, he states that he has observed the same phenomenon in varying amount each year since 1883 and that in this year, 1895, that he observed it for the first time by the second brood of larvæ. Dr. E. P. Felt in Bulletin 109, New York State Museum, 1906, says that he has observed the same thing and in his "Insects Affecting Park and Woodland Trees," New York State Museum, Memoir 8, Vol. 1, states that the habit has not been recorded from other places.

It is an interesting fact that the same thing happened with caged specimens at Purdue University, LaFayette, Ind., during the spring of 1913. On the 26th of May, 1913, a twig of new growth was noticed which had been eaten into for about 7 mm. in length and more deeply on the base end. At the tip end it was eaten about half way through and gradually became deeper throughout the 7 mm. of length, so that at the base it was just hanging by the bark on the lower side. After the twig was cut off for photographing, a larva was seen feeding on the stub remaining in the cage. A few days later four or five more twigs were observed to be in the same condition, some being cut entirely off while others were only partially eaten. One twig was noticed in which the bark was eaten off irregularly for about an inch in length, but the tissue beneath was not touched. In all cases only new wood was affected and it was all done by larvæ in their second instar. After they became older they did not touch the wood. It was not necessary for them to resort to the wood for food at any time, as there was always an abundance of tender leaves kept fresh by standing in a bottle of water, and on which most of the larvæ fed. This habit was not observed out of doors. P. W. Mason, *Agr'l. Exp. Sta., LaFayette, Ind.*

A Correction. My attention has been called by Mr. F. E. Brooks, who has made a study of the mammals of West Virginia, to the fact that the skunk or polecat mentioned in the February issue of the Journal as feeding on the larvæ of the peach borer, was probably not *interrupta* which is not known to occur in that locality. It was more likely to have been either *Mephitis mephitis putida* or *Spilogale putorius*, both of which are known to occur in this locality, the former being the more common (The locality in question was Keyser, W. Va.)

L. M. Peairs, *Morgantown, W. Va.*

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

APRIL, 1914

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

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The sectional meetings have some disadvantages since they have made possible the reading of many more papers within a given time and now we find ourselves with a very large amount of manuscript on hand without the means for publishing it promptly and at the same time provide for the usual additional matter appearing in later numbers. Our limited funds make it necessary to carry over a number of papers and for the remainder of the year contributions may be expected to appear from one to two issues later than originally estimated. We can hardly do more than complete the publication of the proceedings in the June number, and as a consequence some papers will not appear in time to be of the greatest service the coming season.

The large amount of matter and the relatively scanty means raises a question as to the most profitable expenditure of available funds. It has been the aim to restrict the papers largely to original contributions to knowledge, a policy which must be adhered to more rigidly in the future. The business proceedings of recent years are more voluminous and there is a tendency for them to increase in size with the more complete type of organization towards which we are tending. Many of these activities are highly desirable, some are of questionable utility and in certain instances at least the same end could be accomplished with less printer's ink. This latter is true of some contributions to knowledge though most of us find it easier to see the verbosity of the other man than to note such a trait in our own writings.

Current Notes

Conducted by the Associate Editor

A proposed anti-mosquito drainage law is now before the legislature of Massachusetts.

Mr. W. O. Ellis has been appointed instructor in entomology at the Washington State College.

Mr. George G. Ainslie of the Bureau of Entomology is now at work in Florida, with headquarters at Orlando.

Mr. T. J. Talbert has recently been appointed assistant in entomology at the Missouri College and Station.

Mr. Desla Bennion, who has been connected with the Salt Lake (Utah) Station, Bureau of Entomology, has resigned.

William H. Hasey, 1913, Massachusetts Agricultural College, is a graduate student in entomology at the college.

Mr. L. M. Gates has recently been appointed field expert in entomology at the Nebraska Agricultural Experiment Station.

Prof. N. E. Shaw, state nursery inspector of Ohio, addressed the Ohio Nurserymen's Association at Cleveland, January 21, 1914.

Mr. Harry W. Allen, 1913, Massachusetts Agricultural College, is now employed at the parasite laboratory, Melrose Highlands, Mass.

Mr. Henry L. Viereck, sailed on March 5, to collect parasites in Italy, France and Germany for the California Commission of Horticulture.

Prof. J. H. Comstock of Cornell University, has recently been elected one of the twelve honorary members of the Société Entomologique de Belgique.

Mr. S. B. Doten is now director of the Agricultural Experiment Station of Nevada. This is the fifth station to select an entomologist as its director.

According to *Science*, Dr. Creighton Wellman, dean of the school of hygiene and tropical medicine of Tulane University of Louisiana, has resigned his position.

Mr. W. S. Regan, chief deputy nursery inspector of Massachusetts, was operated upon for appendicitis at the hospital in Springfield, Mass., during the holidays.

Mr. Clyde M. Packard, a graduate of the Massachusetts Agricultural College, class of 1913, now has a position in the Bureau of Entomology and is stationed at Hagerstown, Md.

Mr. Roy E. Campbell, B.S., 1913, University of California, has accepted an appointment in the branch of Truck Crop and Stored Product Insect Investigations, Bureau of Entomology.

Mr. P. M. Eastman, Massachusetts Agricultural College, class of 1908, is inspector of nurseries for the New York State Department of Agriculture, with headquarters at Albany.

Mr. Ray T. Webber has been appointed as scientific assistant, Bureau of Entomology, and is now engaged in experimental work at the Parasite Laboratory, Melrose Highlands, Mass.

According to the *Review of Applied Entomology*, Mr. C. F. Beeson, Indian Forest Service, has been appointed forest Zoölogist to the Government of India, *vice* Dr. A. D. Imms, resigned.

Mr. George W. Barber has recently taken a position in the Bureau of Entomology and is located at Hyattsville, Md. Mr. Barber is a graduate of the Massachusetts Agricultural College, class of 1913.

Francis Jager has been appointed professor in apiculture and apiarist, and William Moore, assistant professor in entomology, at the University of Minnesota and the Agricultural Experiment Station.

Mr. L. L. Scott, Entomological Assistant, Bureau of Entomology who was assisting Mr. A. G. Hammar in codling moth investigations in the Pecos Valley, New Mexico, resigned from the service February 14, 1914.

Messrs. W. B. Wood and E. H. Seigler have been detailed for work during the spring months in California in connection with the Bureau's investigations and demonstration work in the control of the pear thrips.

Mr. Chester F. Turner, of the Kansas Agricultural College, has accepted an appointment in the Bureau of Entomology, Cereal and Forage Crop Investigations, and has been assigned to the Greenwood (Miss.) Station.

Mr. Curtis P. Clausen, B.S., 1914, University of California, has accepted an appointment in the Branch of Truck Crop and Stored Product Insect Investigations, Bureau of Entomology, with headquarters at Berkeley, Cal.

Mr. Joseph J. Pillsbury, a graduate of the Massachusetts Agricultural College, class of 1913, is engaged in field work on the gypsy moth in New Hampshire, with headquarters at the parasite laboratory, Melrose Highlands, Mass.

Dr. J. E. Wodsedalek, formerly of the department of zoölogy, University of Wisconsin, has been appointed head of the department of zoölogy and entomology at the Idaho University and Station, the position formerly held by Prof. J. M. Aldrich.

Mr. Lawrence P. Rockwood, a graduate of the Massachusetts Agricultural College, class of 1912, is employed by the Bureau of Entomology, and is located at Salt Lake City, where he is engaged in rearing parasites for the control of the alfalfa weevil.

Mr. W. F. Turner, Entomological Assistant, Bureau of Entomology, formerly assigned to work under the Insecticide and Fungicide Board, has been transferred to the Office of Deciduous Fruit Insect Investigations, and will assist Mr. Baker in studies of orchard plant lice.

A monthly *News Letter* will now be issued in the Bureau of Entomology, giving an account of changes in personnel, activities of divisions and men, and methods of work. The first number was issued in March, and the *News Letter* will be sent to all connected with the Bureau.

Dr. E. F. Phillips, in charge of bee culture investigations of the Bureau of Entomology, and Mr. George S. Demuth are conducting investigations on the temperature of the bee colony in winter, at the Zoölogical Laboratory of the University of Pennsylvania, at West Philadelphia.

Mr. A. I. Fabis, a graduate student of Columbia University, New York City, and formerly a student at Cornell University, has been employed as scientific assistant,

Bureau of Entomology, and will assist Mr. John B. Gill in pecan insect investigations, with headquarters at Monticello, Fla.

At the annual convention of the New England Nurserymen's Association, held at Hartford, Conn., February 24 and 25, 1914, the subject of pests and inspection was discussed by Prof. W. C. O'Kane, Durham, N. H.; Mr. D. M. Rogers, Boston, Mass.; Dr. G. P. Clinton and Dr. W. E. Britton, New Haven, Conn.

According to *Science,* Carlos E. Porter, professor of zoölogy and entomology at the Agricultural Institute of Chile and director of *Revista Chilena de Historia Natural,* is vice-president for 1914, of the Sociedad Cientifica de Chile and honorary professor of zoölogy at the Agricultural College of the University at Manaos, Brazil.

Mr. Boyd L. Boyden, who pursued a course in biology at Pomona College, Claremont, Cal., graduating as B.S. in 1912, has been transferred from work on tropical and sub-tropical insect investigations to the branch of Truck Crop and Stored Product Investigations, Bureau of Entomology, with temporary headquarters at Whittier, Cal.

Mr. Benjamin R. Leach, a student at Cornell University, has been appointed as scientific assistant in deciduous fruit insect investigations, Bureau of Entomology, and will give special attention to habits, in orchards, of the woolly apple aphis and to experiment with remedies in the control of this insect. Headquarters will probably be Winchester, Va.

The ninth annual convention of the Tennessee State Horticultural Society, State Nurserymen's Association, and State Beekeeper's Association, was held at Nashville, Tenn., January 28, 29 and 30, 1914. Prof. H. A. Morgan gave an address before the Horticultural Society, and Prof. G. M. Bentley addressed the Nurserymen's Association, of which he is secretary-treasurer.

Mr. John E. Dudley, Jr., formerly connected with the Gypsy Moth Parasite Laboratory at Melrose Highlands, Mass., has been appointed as scientific assistant in the Bureau of Entomology, and assigned to work under the Insecticide and Fungicide Board. He will assist Mr. E. W. Scott in testing the efficacy claims of manufacturers as regards their insecticides, with headquarters at Vienna, Va.

At the University of Kansas Mr. P. W. Claassen has been appointed assistant state entomologist on the staff of the state entomologist of the University of Kansas, who is a member of the entomological commission. Mr. H. B. Hungerford has been advanced to the rank of assistant professor. The Board of Educational Administration has recently made a special appropriation of $1,500 per year for the next biennium, to be used by the state entomologist in charge of the southern half of the state in connection with his investigations on native grasshoppers. They have also granted him $300 additional appropriation for the investigation on pellagra and the sand fly.

Mailed April 15, 1914

④# JOURNAL
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VOL. 7 JUNE, 1914 No. 3

Proceedings of the Twenty-sixth Annual Meeting of the American Association of Economic Entomologists

(*Continued.*)

Morning session, Friday, January 2, 9.30 a. m.

PRESIDENT P. J. PARROTT: The first paper on the program will be read by Dr. W. E. Britton, entitled "A Remarkable Outbreak of *Culex pipiens.*"

A REMARKABLE OUTBREAK OF CULEX PIPIENS LINN.

By W. E. BRITTON, *State Entomologist, New Haven, Conn.*

Each year, at least for three years, throughout the entire western portion of the City of New Haven, there has been an outbreak of rain-barrel mosquitoes, *Culex pipiens* Linn., beginning the latter part of July and lasting until cold weather. Through this part of the city flows West River, a small stream formed by the union of three smaller streams just above the Whalley Avenue bridge. South of this bridge the stream runs through Edgewood Park and into widening meadows which at the lower end are tide marshes.

Though the writer has resided nearly half a mile west of this river since 1904, and just east of it for six years prior to that time, he has never seen these mosquitoes in such abundance as during the past three years. It was known that their breeding place was close at hand, for rain-barrel mosquitoes do not breed in the brackish water of the salt marsh. In 1912, when all known mosquito breeding places in and near the city were drained or oiled, these mosquitoes were still a great nuisance and their presence tended to discredit the work which had been done. Many who had contributed toward the mosquito fund

complained. They had paid their good money but there were just as many mosquitoes as before.

Much searching was therefore done for rain water barrels, though a thousand of them could not have produced all the mosquitoes present. They fairly swarmed in protected corners of buildings, under verandas, and in shrubbery. They were small and entered houses through the meshes of the screens. They were innocuous during the day, but as soon as it was dark they began to sing and to bite. Unless the windows were kept closed or mosquito bars placed over the bed, a good night's sleep was impossible.

On August 5, one of my assistants, Mr. L. B. Ripley, was sent to examine all pools in Edgewood Park. He happened to dip into the edges of the main stream (West River) and obtained wrigglers, especially in the little coves and in other places where, choked by vegetation or rubbish, the water was quiet. In the middle of the stream there was no breeding; the current prevented it. Small pools under the Whalley Avenue bridge were literally alive with *Culex* larvæ.

Mr. Ripley reported the facts to me, and then the stream was examined toward the north and west. In the west branch, nearly as far as the Pond Lily Company's Dye Works, wrigglers were extremely abundant, especially along the edges and outside of the main current which was slight on account of the very low water, almost no rain having fallen in June and July. At one dip of the ladle, which holds about a gill, 200 wrigglers were taken.

It was apparent that the fish had been killed or driven from the water by the dye stuffs from the Pond Lily Company's factory, though rain-barrel mosquitoes, which often breed in strongly polluted water, were able to breed in this stream. Heavy rains would probably have flushed out the stream but with the lack of rain, and the absence of fish, mosquitoes took possession of the water and were breeding there literally by millions. These wrigglers clustered around stones, leaves, or other objects in the water and could be seen from the banks at a distance of perhaps 15 feet; little or no breeding was found in the other branches of West River where the water was clear.

Thus the mystery had been solved and the source of the mosquito nuisance had been discovered. Up to this time the main stream had not even been suspected as a possible breeding place.

During the next few days the surface of the river, where mosquito wrigglers could be found, was sprayed with oil from a point opposite Ramsdell Street near the Pond Lily Dye Works to the Whalley Avenue bridge, a distance of nearly one and one-half miles of the winding course of the stream. Also the canal near the paper mills, and many detached breeding pools that in high water are connected with the

river were treated. The winding course of the stream, with its brush-grown banks and its rough and irregular bed, partially filled with vegetation and rubbish, made the work difficult and expensive. The entire cost of this work amounted to $125.31. Apparently these mosquitoes were a nuisance nearly a mile distant from West River.

Another interesting outbreak of rain-barrel mosquitoes which occurred in 1913 in Greenwich, Conn., was described to me in a letter by Mr. Edwin M. Skinner, president of the United States Drainage & Irrigation Co., of New York City. Just north of the village of Mianus, there is a dam six or eight feet above tide level, formerly used for furnishing power for the Palmer Brothers' gas engine plant, but now abandoned for another site where steam is used. About 500 yards north of the Palmer dam, is another dam about six feet high, where a gristmill used to stand but of which only the sluiceway and part of the water wheel remain. These dams are not used, but on account of sewage emptying into the river above and between them, they are allowed to remain rather than permit the sewage to be exposed.

A short distance above the second dam there is a mill where lap-robes and cheap plush goods are made from cow-hair and low grade wool. A cheap grade of oil is used in spinning the raw wool and cow-hair, and the product is washed with water from the river which again flows into the stream. Probably dye stuffs are also used and emptied into the river. These waste materials, together with the sewage held back by the dams, probably destroyed the fish and furnished an ideal breeding-place for rain-barrel mosquitoes. The stream flow was slight in the period of drought, and the water was stagnant and slimy and thick with wrigglers. The river is about 100 feet wide by the gristmill dam and perhaps 150 feet broad at the Palmer dam and literally filled with larvæ.

Above the woolen mill is another dam, above which the water is pure and sweet. The health officer ordered the gates lifted at this upper dam and all the wrigglers were washed into Long Island Sound the same day that they were discovered.

Howard, Dyar and Knab[1] record a similar outbreak near Urbana, Ill., where a creek is practically stagnant in late summer. At a certain point this creek receives the waste from a slaughter house, and for some distance below was so charged with decomposing animal matter that no fish could live in it, though it contained millions of wrigglers of rain-barrel mosquitoes. Adults covered the trees and bushes along the banks, but their presence was felt only for a short distance, and few of

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[1] The mosquitoes of North and Central America and the West Indies, Vol. I, p. 135, 1912.

them reached the town perhaps a mile away. They continued to reproduce until cold weather.

MR. FRANKLIN SHERMAN, JR.: It may be of interest to note that at Raleigh, N. C., during the past summer we have found quite abundantly what seems to be the yellow fever mosquito.

PRESIDENT P. J. PARROTT: I will now call for the paper by Dr. T. J. Headlee, entitled "Anti-Mosquito Work in New Jersey."

ANTI-MOSQUITO WORK IN NEW JERSEY

By THOMAS J. HEADLEE, Ph. D., *New Brunswick, N. J.*

About fourteen years ago the late Dr. John B. Smith began seriously to study the mosquitoes of New Jersey for the purpose of finding out how they might be brought under control. He soon developed the fact that New Jersey, in addition to the fresh water breeding species common to other states, had certain species which, breeding in the brackish waters of the salt marshes, habitually flew and were wind-carried many miles inland. All told he found 35 species of fresh water breeding mosquitoes and 5 species of brackish water breeders.

SALT MARSH WORK

Of the species of salt marsh mosquito recognized by Doctor Smith, *Aedes cantator* Coq., and *Aedes sollicitans* Wlk., are really very important. The former is especially abundant in North Jersey during the early part of the season and the latter characteristic of South Jersey and of the later season broods in the north.

These two species were found to oviposit in damp mud and the eggs to remain viable for long periods. Not more than 95 per cent of the eggs laid during any one season hatch during that season; at least 5 per cent wintering over. In this way the mosquito-infested salt marshes are always abundantly stocked with eggs. Apparently eggs are always ready to hatch for in a few hours after the pools have been filled tiny wrigglers make their appearance. About eight days of warm weather are sufficient to transform to pupæ and the pupæ to give up broods of blood-thirsty adults.

Before their breeding grounds were interfered with these two species covered at times a band of shore line about forty miles wide extending from Jersey City down along the coast and around Cape May to and including a considerable part of Salem County. A small area of shore in Monmouth County has always been sufficiently distant from mosquito-breeding marshes to be practically free from mosquitoes, and that part of the coastal strip exposed to strong breezes from the sea has been practically free except when the wind blew from the land.

It was early found that any meadow which was covered at frequent intervals by the tide was free from breeding while any meadow covered only at long intervals or rarely at all reached was sure to breed. Parts of the meadow cut off from tidal covering by dikes or railway grades, garbage or mud fills or parts that are so high lying that the tide only rarely covers them may be expected to breed immense numbers of mosquitoes.

It is our observation that the frequently submerged meadows are not prevented from breeding so much by the change and movement of the water as by the presence of small minnows which are commonly designated as "killifish." If the extra high tides should fill the pools of the high lying meadows with fish no mosquitoes can be found breeding in them. Of course, if the pools are left long exposed without replenishment from either tides or rains, they dry up and the fish die and when rain refills them, breed mosquitoes in enormous numbers.

Salt marsh mosquito breeding occurs not only in the pools, but under favorable conditions may go on in the coarse grasses. This type of breeding becomes possible only when the lower parts of the grass stems are submerged for a period sufficient to permit development. Of course, breeding in such spots is prevented by "killifish" when they happen to be present.

It seems to the writer that the greatest single factor in determining where mosquito breeding may occur on the salt marsh is the distribution of the "killifish." So efficient are they in the destruction of wrigglers that wherever they may be no mosquitoes can breed during the period of their residence. Furthermore, they seem possessed of the desire to penetrate the marsh as far as the water will permit and may frequently be seen nosing their way among the grass stems in water two inches deep.

The 200,000 acres of the Jersey salt marsh present all sorts of breeding conditions.

That section which lies about Newark Bay and the lower course of the Hackensack River is made up mainly of the "shut-in" and "high-lying" types of meadow. Breeding originally did occur throughout this area and the swarms of mosquitoes produced inundated the cities on its borders. Of all the municipalities that suffered from that plague, Newark, a city of 350,000 people, was the worst afflicted. When a flight was on, I am told, the electric lights were obscured and public meetings broken up.

Those parts of these meadows into which sewage is still poured and which are without proper outlets still breed mosquitoes and today form the most serious salt marsh mosquito problem of North Jersey.

The lower course of the Hackensack River is bordered in many places by vast cat-tail areas. In such of these as do not show a rise and fall of the water and expose at no time areas of muddy bottom, the salt marsh mosquito does not breed, probably because no suitable place for egg deposition can be found. Cat-tail areas in which the muddy bottom is exposed for considerable periods breed mosquitoes in enormous numbers. The marshes along the Hackensack River breed more salt marsh mosquitoes at the present time than any other part of the North Jersey salt marsh.

That section of salt marsh which lies along the lower part of Newark Bay and the Arthur Kill is less shut in and therefore less difficult to prevent from breeding. From the Arthur Kill southward along Raritan Bay, and Shrewsbury River, the meadows are narrower and more easily drained.

The meadows of Barnegat Bay are great breeders because the tide fall is small (about 12 inches) and the opportunities for the distribution of "killifish" correspondingly poor.

The marshes between the Mullica and Great Egg Harbor Rivers are frequently swept by tides and only those parts of the meadow that join the highland and the sand strip breed.

The marshes of the Atlantic coast from the Tuckahoe River to the end of Cape May are like the preceding.

Much of the marsh of the bay shore is shut in behind a low sand strip and the natural drainage greatly obstructed, causing it to breed mosquitoes in enormous numbers.

The marshes of the valleys of the Mullica, Great Egg Harbor and the Tuckahoe Rivers are broad and apparently great breeders of mosquitoes. The marshes along the rivers and creeks opening into Delaware Bay have experienced a considerable amount of agricultural development and breed correspondingly fewer mosquitoes.

Mosquito control on the salt marsh was, according to Doctor Smith, a matter of doing away with mosquito-breeding pools and standing water generally. Ditches 10 inches wide by 30 inches deep with perfectly straight, smooth sides and proper outlets are cut through the meadows at distances such as will carry off the surface water. If the pools are not drained by this means they are tapped by spurs. Small pools are usually filled with sods taken from the ditches, and in a few years become smooth meadow. Occasionally areas of meadows are found so located that ordinary ditching is impracticable. In such cases the meadow is trenched with ditches as described and perhaps if the trenches cannot contain all the water an artificial lake is cut in the lowest part. Trenches and artificial pool are connected and the system stocked with "killifish" which are usually able to main-

tain themselves for two or three years. In this way all the water containing parts of the marsh are open to the fish or laid dry at low tide and breeding cannot occur.

In this way the salt marsh from Jersey City to Barnegat on Barnegat Bay, with the exception of certain parts of the Hackensack marshes, recently found breeding, have been rendered practically free from mosquito breeding. The state has cut most of the ditches. Much of this drainage is now being cared for and extended by the counties and the writer hopes in the near future to have all of it so handled.

The results of this drainage have been little short of marvelous. Shore properties which at certain seasons of the year were uninhabitable are now delightful summer resorts. From Jersey City to Rumson shore, property has increased five and a half million dollars and the greatest percentage of increase has taken place in the purely residential districts. In one instance the increase amounted to 300 per cent.

A very natural but rather unexpected result of the drainage was a marked increase in the yield of salt marsh hay. Fairly careful estimates show that the marsh which is drained three years or more yields 2.6 tons per acre as compared with .7 of a ton from the undrained marsh. As this hay is worth $8 a ton the drained marsh makes a yield worth consideration.

About 60,500 acres have already been ditched and 139,500 acres yet remain. The average cost of ditching does not exceed $5. Fairly careful estimates indicate that the completion of this drainage would in short time increase taxable property values by at least $26,000,000.

The Atlantic Coast of New Jersey is fitted by nature to become the playground of the East and to the end that it may become so the mosquito must go.

Doctor Smith tried several types of organization before he hit upon the one under which most of the salt marsh drainage has been carried on. First a law was enacted (1904) declaring a mosquito-breeding place a nuisance and making it the duty of local boards of health to cause its abatement. Then a law was enacted making state funds available to municipalities which desired to abate salt marsh mosquito-breeding places, providing the municipalities would themselves contribute a heavy percentage of the cost of abatement. Finding that neither of these laws brought about satisfactory progress, he secured the passage of chapter 134, Laws of 1906, in which the director of the New Jersey State Agricultural Experiment Station was charged with the duty of causing the abatement of salt marsh breeding places acting through the authority of local boards of health

and doing the work with funds appropriated by the state. One of the provisions of this act enabled municipalities active in the abatement of salt marsh mosquito breeding to obtain state aid. The entomologist was appointed by the director of the Experiment Station as his executive officer and Doctor Smith thus came to be in full charge of the work.

In some ways the work has shown certain defects in the law which must soon be modified to fit present conditions. Since its enactment the work of ditching has demonstrated the need of more police power and the enactment of a law (1912) creating county mosquito extermination commissions has brought about a relation for which there is nothing specific in the 1906 law to provide.

Inland or Local Mosquito Work

Doctor Smith's studies showed that the really important fresh water breeding species of mosquito could be roughly thrown into four groups: the house mosquito, the malarial, the swamp mosquito and the woodland pool mosquito.

The house mosquito and the species composing the malarial group winter in the adult stage in protected places, showing a strong preference for the cellars of dwellings as a place for hibernation. Eggs are laid on any stagnant or partly stagnant water and one brood follows another. These mosquitoes breed in all sorts of pools, but the malarial group is usually to be found in cleaner water. The larvæ of this group are frequently found along the grass-overgrown banks of streams. The house mosquito breeds wherever the water stands long enough for it to come through. Lot, garbage dump and roadside pools, cesspools, sewer catch basins, rain barrels and roof gutters are common breeding places for this species.

The principal swamp mosquito species—*Aedes sylvestris* Theob.—passes the winter in the egg stage at the bottom of pools and the adults are on the wing throughout the season. While not a migrant like the principal salt marsh species, a mile or two is easy and five miles are not beyond its powers. While such areas as the Great Piece Meadows of northern New Jersey produce this species in enormous numbers, the great cedar swamps of South Jersey breed few of this or any other species.

The important members of the woodland group winter in the egg state on the mud or submerged débris. The larvæ appear very early and the adults are the earliest of the really troublesome mosquitoes to get on the wing. They are most abundant during the early part of the season and cease to be noticeable as it progresses.

The *Coquillettidia perturbans* Wlk., is at once the hardest biter and

has the most peculiar larval life of the more important species. It breeds in places that partake of the nature of a woodland pool and of a swamp. The larvæ never come to the surface for air; but remain for their entire life among the grass roots at or near the bottom of the pool.

Beginning in late April the woodland species get on the wing and continue to be troublesome to persons living near or penetrating their haunts until midsummer, when they almost cease to be noticed. When breeding places for *Aedes sylvestris* Theob., the swamp mosquito, are present it will appear with the woodland species and stay for the rest of the season.

The house mosquito usually begins to appear in troublesome numbers in late June and by the middle of July is abundant, and continues so until cold weather stops its breeding and sends it into winter quarters. We usually think of this species as migrating only a few hundred yards, but the work of the past summer has indicated that when bred over a large area in enormous numbers it infests adjoining territory for nearly or quite 2.5 miles.

Inasmuch as this fact, in the writer's belief, is being formally recorded for the first time, the proofs upon which it rests should be set forth with some care.

The entire territory included in the counties of Union and Essex was under constant observation throughout the last two mosquito-breeding seasons. With the exception of the Ebling marsh, which lies to the southeast of the City of Newark, the mosquito breeding in Essex and Union Counties was under such good control, that an expert would have to search this territory for some time before he found pupæ of fresh water breeding mosquitoes. About fifty acres of the Ebling meadow, which was waterlogged with sewage, began breeding *Culex pipiens* Linn. and *Culex salinarius* Coq., about midsummer and continued throughout the season with the exception of certain periods when extra high tides cleared the sewage out sufficiently for "killifish" to penetrate or the efforts of the Essex County Mosquito Extermination Commission resulted in the destruction of a brood.

The southern part of the City of Newark and the northern part of the City of Elizabeth exhibited a far larger number of mosquitoes (both *C. pipiens* and *C. salinarius*, but mainly the former) than did other parts of these counties. This concentration was practically coincident with the heavy breeding on these sewage-charged marshes. The pupæ were just as difficult to find in the districts heavily infested as they were in districts in which there were not enough mosquitoes

to occasion complaint. By means of a large number of night collections, made at the same hour, in the same fashion and in as nearly similar localities as the nature of the topography would permit, a zone of mosquitoes was traced from the Ebling meadows through South Newark into North Elizabeth, a distance of 2.5 miles.

Briefly stated, the proof of the *Culex pipiens* spreading from a heavy breeding area is: (1) A concentration of the species in a definite locality some distance from the breeding place; (2) absence of sufficient local breeding to explain the infestation; (3) the discovery of a zone of mosquito infestation from the great breeding place to point infested.

Soon after the house mosquito makes its appearance the malarial species develops and continues in increasing numbers throughout the breeding season.

For many years various civic bodies and associations made intermittent efforts at mosquito control, but it was not until the creation of the county mosquito extermination commissions that a really efficient local agency for mosquito work came into existence. The failure of other local agencies was due to the fact that mosquito control was only one of their objects and that they were willing to neglect it for something which, at the time, appeared to be of greater importance.

The county mosquito extermination commission act is an admirable attempt to unite in a practical fashion the local and state anti-mosquito agencies and is well calculated to secure men of proper caliber as commissioners. Under its provisions the supreme court judge presiding over the courts of each county is compelled to appoint a commission of six men, three of whom shall have been at some time connected with board of health work. These commissioners must serve without pay and each commission is charged with the duty of preparing annually a statement of plans and methods for controlling the mosquitoes within the limits of their counties and an estimate of the expense necessary thereto.

The director of the New Jersey Experiment Station is *ex-officio* member of each commission and must pass annually on each statement of plans, methods and financial estimates submitted. The director has power to modify this statement as he sees fit, but is under obligation on or before a specified date to forward the approved statement to the board of chosen freeholders of the county from which it came. On the receipt of this statement by the board of freeholders it becomes obligated to make the appropriation.

So far as the writer's experience goes, and he has become personally acquainted with all the commissions that have exhibited a desire to do something, the supreme justices have appointed a very capable and public-spirited body of men. Very wisely the commissions, in

counties where public sentiment would not support mosquito work, have done nothing. Wherever the people would support work, either it has already been started or movements looking towards its beginning have been initiated.

In 1912, the year the law was enacted, Essex and Union Counties began work, with $75,000 and $28,000 respectively. When the law was in jeopardy in the legislative session of 1913 their legal representatives stood by it solidly and were largely instrumental in preventing its repeal or amendment.

In 1913 Essex, Union, Hudson and Atlantic worked with $70,000, $26,000, $32,000 and $26,000 respectively. Published reports of their work are available to those who are interested. During the same year Passaic, Bergen, Camden, Cape May and Gloucester Counties had small appropriations for preliminary work as follows: $8,500, $500, $500, $500 and $50.

In all cases where funds were sufficient for the active work of protecting a whole county, the commission has proceeded to organize a force of inspectors and laborers headed by a chief inspector on whom the duty of, and the responsibility for, mosquito control falls. The county is divided into districts of such size that the inspectors can, during the breeding season, cover the breeding places every ten or twelve days. The laborers are used to eliminate such breeding places as can be destroyed. Pools are drained or filled, the margins and banks of brooks and ponds are cleared and walls made perpendicular so that fish can reach every part and consume the wrigglers.

Briefly stated, the general plan is to find all the breeding places, eliminate all of them that can possibly be eliminated by draining, filling, cleaning or stocking with fish and to oil at regular intervals all breeding places that cannot be eliminated.

Of course, the county mosquito extermination commissions take charge of the salt marshes within their limits, keeps the ditches clean and extends them as the evolution of the marsh demands.

Summary and Conclusion

The state has undertaken the drainage of the salt marsh. Already 100 miles of the coast have been drained with large resultant increases in property values. A law has been enected by means of which good local agencies for mosquito control have been formed and closely related to the state mosquito control work. This local agency has proven successful wherever it has had a chance to work with a full force and has obtained the support of the taxpayers. The local movement is spreading rapidly. This local agency helps to estab-

lish and keep in repair and extend the salt marsh drainage established by the state. The outlook for the early elimination of the Jersey mosquito is at the present time bright.

President P. J. Parrott: The next paper on the program is entitled "Experiments with House-Fly Baits and Poisons," by Mr. A. W. Morrill.

EXPERIMENTS WITH HOUSE-FLY BAITS AND POISONS

By A. W. Morrill, *Phoenix, Arizona*

While it is generally accepted that as a rule the most practicable means for the control of the house-fly is the prevention of its breeding, work directed against the adult insects, particularly in rural districts, must be relied upon to a considerable extent as a protection against this disease-carrying pest. There are many situations where fly traps, fly poisons and even sticky fly paper are the only practicable means of protection and many more where such means are valuable accessories to the more desirable methods of protection.

The experiments upon which this paper is based were planned with the view to securing more definite information than was available concerning the comparative attraction for the house-fly possessed by some of the many materials used and publicly recommended for use as fly trap baits or fly poisons. This information was especially needed for the determination of standards for comparison with certain commercially exploited mixtures made by secret formulæ and claimed by the promoter to be superior to all other known fly poisons and baits. While the results meet this primary object, the continuation of the experiments promises further results of practical as well as scientific interest. In these experiments the writer has been materially aided by Mr. George Acuff, crop pest inspector at Phoenix.

Unless otherwise stated the baits or poisons were exposed in watch glasses in the bottom of small dome-shaped fly traps of the style devised by Professor Hodge. This provided for the exposure of equal amounts of the materials which were being tested. The traps were placed out of doors in a row about fifteen inches apart and so far as could be determined by general observations there was no material advantage in one location over another. The period of exposure was from three to four hours during the warmest part of the day. After exposure the flies were killed by means of carbon bisulfid fumes and the number captured recorded in each case. Where the baits were poisoned, dead flies found in the bottom pan-like section of the trap

were also counted. In one case, when formalin was used in the trap, dead flies outside several cages were counted and were found to represent only 5.3 per cent of the total killed and captured alive. In the other experiments those which escaped after feeding on the poison were not taken into consideration.

The principal results of the cage or fly trap experiments are presented in Table I. In order to group the different bait materials for convenience in making comparisons, wherever a combination was tested, an extra listing in the table has been made for each ingredient with the exception of water. Commercial formalin (40 per cent) mixed with water at the rate of one part to ten was included in all of the tests except those made on one day, December 12, and this mixture provides a good basis for comparisons with the other materials. The figures given represent the percentage of the total catch each day.

In addition to the tests included in the following table several others were made. In one series the following fly collections were recorded: Beer, 527; sweet milk, 268; sour milk, 268; decayed banana, 228; fresh banana, 135; cheese, 107; fresh orange, 99; cane sugar, 43; decayed apple, 26; fresh apple, 5.

To test the killing effects of those substances used as poisons in the fly trap experiments a third series was made with the poisonous bait exposed in watch glasses outside of the traps and resting on papers to facilitate the counting of the dead insects.

Bichromate of potash was included with the other materials on account of its endorsement in a newspaper dispatch concerning a Kansas state board of health bulletin. Whether or not the substance was recommended as a fly poison in the bulletin referred to the writer has never ascertained. It is evident, however, that it is of little value as compared with formalin, cobalt and alcohol.

One series of experiments was made with tanglefoot fly paper to determine whether it was practicable to increase the attraction this paper has for flies. Dried blood moistened with water and placed in a watch glass near the center of a sheet attracted 465 flies as compared with 324 flies attracted to a nearby sheet which was lightly sprayed with 40 per cent formalin, and 230 flies attracted to an untreated sheet. In another instance a sheet of the fly paper with a small piece of banana near the middle attracted 363 flies, as compared with 350 attracted to a sheet having dried blood rubbed into the sticky surface, 283 attracted to an untreated sheet, 266 attracted to a sheet treated with bichromate of potash and 210 to a sheet treated with cobalt. In these four tests where substances were added an equal area near the middle of the sheet was treated in each case. Dried blood moistened with water and decayed banana were tested by treating a square inch of

TABLE I

ATTRACTIVENESS OF FLY BAITS AS INDICATED BY PERCENTAGES OF TOTAL FLIES CAPTURED

	Date of test, December, 1913	10	12	17	18	22	23	24
	Vinegar Group:							
1	Vin. (plain)	4.0						
2	Vin.-sugar	36.5				22.0		
3	Vin.-bread	25.0						
4	Vin.-form. (10–1)	8.6						
5	Vin.-sugar-water (1–1–1)					19.5		
6	Vin.-water-dried blood (1–1–1)					7.5		
	Formalin Group:							
7	Form. (40%)	.1			11.0			2.6
8	Form.-bread	15.0			0.			8.4
9	Form.-water (1–20)	5.4			.1			
10	*Form.-water (1–10)*	*.6*		*3.5*	*8.0*	*1 0*	*2.4*	*7.9*
11	Form.-water (1–5)	1.0			1.2			
12	Form.-water-sugar (1–10–1)				4.1	3.5		
13	Form.-water-bread (1–10)	3.3			3.4		14.5	17.5
14	Form.-water-bran (1–10)				2.8			
15	Form.-water-beer (1–5–5)				32.9	10.3		
16	Form.-water-milk (1–5–5)				3.9	11.3		
17	Form.-water-dried blood (1–5–5)			21.4	8.4	3.5		
18	Form.-beer-milk (1–5–5)				28.7			
19	Form.-water-bichr. of pot. (1–20–1)				.6			
4	Form.-vinegar (1–10)	8.6						
	Alcohol Group:							
20	Alc. (95%)							7.3
21	Alc.-water (1–10)			11.0		6.2		4.6
22	Alc.-water (1–20)		.4			1.7	11.0	
23	Alc.-cane-syrup (1–20)		3.4					
24	Alc.-water-bran (1–20)		26.0					
25	Alc.-water-cobalt (1–20–1)		5.5					
26	Alc.-water-bichr. of pot. (1–20–1)		2.1					
27	Alc.-water-sugar (1–20–1)					8.0		
28	Alc.-water-beer (1–10–10)					3.4		
29	Alc.-water-dried blood (1–20–1)					2.0		
30	Alc.-water-bread (1–20)						33.5	17.2
31	Alc. (95%)-bread							17.4
	Bichromate of Potash Group:							
19	Bichr. of pot.-form.-water (1–1–20)				.6			
26	Bichr. of pot.-alc.-water (1–1–20)		2.1					
32	Bichr. of pot.-water (1–20)			.2				
	Cobalt Group:							
25	Cobalt-water-alc. (1–20–1)		5.5	4.6				
33	Cobalt-water (1–20)						3.0	
34	Cobalt-water-bread (1–20)						7.3	
35	Cobalt-water-dried blood (10–10–1)			3.0				
	Milk Group:							
36	Milk (sweet)		7.6				1.7	
37	Milk (sour)		3.8				2.5	
16	Milk-water-form. (5–5–1)				3.9	11.3		
18	Milk-bread-form. (5–5–1)				28.7			
38	Milk (sweet)-bread						17.1	
39	Milk (sour)-bread						7.0	

TABLE I.—*Continued*

	Date of test, December, 1913	10	12	17	18	22	23	24
	BEER GROUP:							
15	Beer-water-form. (5–5–1)				32.9	10.3		
40	Beer (fresh)		48.5					
41	Beer (stale)		3.8					
18	Beer-milk-form.(5–5–1)				28.7			
28	Beer-alc.-water (10–1–10)					3.5		
	BREAD GROUP:							
42	Bread-water							13.5
3	Bread-vinegar	25.						
8	Bread-formalin (40%)	15.			0.			8.4
13	Bread-form.-water (1–10)	3.3			3.4		14.5	17.4
38	Bread-milk (sweet)						17.1	
39	Bread-milk (sour)						7.	
30	Bread-alc.-water (1–20)						33.5	17.2
34	Bread-cobalt-water (1–20)						7.3	
31	Bread-alc. (95%)							17.4
	DRIED BLOOD GROUP:							
43	Dried blood			0.				
44	Dried blood-water			14.6				2.8
17	Dried blood-form.-water (5–1–5)			21.4	8.4	3.5		
35	Dried blood-water-cobalt (10–10–1)			3.0				
29	Dried blood-alc.-water (1–20)					2.0		
6	Dried blood-vin.-water (1–1–1)					7.5		
	ANIMAL MATTER GROUP:							
45	Flies (dead)			0.				
46	Meat (fresh)			2.4				
47	Meat (decomposed)			3.0				
48	Fish (fresh)			4.5				
49	Fish (decomposed)			.2				
43	Dried blood			0.				
44	Dried blood-water			14.6				
	SUGAR GROUP:							
2	Sugar-vinegar (1–1)	36.5				22.		
12	Sugar-form.-water (1–1–10)					3.5		
5	Sugar-vin.-water (1–1–2)					19.5		
27	Sugar-alc.-water (1–1–20)					8.0		
50	Water							.9
	Number of cages	10	9	12	13	13	10	11
	Total number flies captured	2,844	1,011	458	3,291	1,537	740	999

fly paper surface with each and comparing the two treated with two untreated sheets. This resulted in the capture of 86 flies on the sheet treated with banana, 37 on the sheet treated with dried blood and 34 and 21 respectively on the two sheets not treated.

The writer's attention was called to the apparent difference in the attractiveness of old and new wire fly traps by Mr. Acuff. An old rusted trap was tested twice in comparison with a new trap of the same kind. With fresh milk as a bait the new trap captured 13 flies

and the old trap one fly. With dried blood moistened with water the new trap captured 28 and the old trap 12. Combined, the new trap captured 41 and the old trap 13 in the two tests.

TABLE II

Date, December, 1913	Material used	Flies killed	Percentage of total
17	Cobalt (1) water (20) and bread	101	47
17	Formalin (1) water (10) and bread	78	36.2
17	Cobalt (1) water (20) and dried blood	20	9.3
17	Bichromate of potash (10 dms.) water (2 oz.) and bread	16	7.4
18	Formalin (1) water (10)	259	41
18	Alcohol (1) and water (20)	253	40.2
18	Cobalt (1) and water (20)	104	16.5
18	Bichromate of potash (10 dms.) and water (2 oz.)	13	2.1

Conclusions from the Experiments

Vinegar in itself is an excellent bait for a fly trap but when used with sugar or bread its attractiveness to flies is greatly increased. Equal parts of vinegar, sugar and water appear to be approximately as attractive as equal parts sugar and vinegar. An attractive combination poisonous to flies can be made with formalin and vinegar but further tests are necessary to determine the best proportions.

Formalin (40 per cent) differs greatly on different days in its attractiveness to flies. This variation is evidently not due directly to temperature conditions, and it suggests the possibility of the flies themselves differing from day to day in the degree of the sensitiveness of the sensory organs. Formalin, as is well known, makes an excellent fly poison when combined with other substances. The usual dilution of the commercial or 40 per cent formalin at the rate of about one part to about ten parts of water seems to be as good as at any other rate. Beer, milk and bread, in the order named, are excellent materials to use with formalin, increasing its attractiveness many times. The addition of sugar increased the attractiveness of the formalin solution but not to a satisfactory degree.

Commercial alcohol (95 per cent) and water at the rate of one to 20 appears from the experiments to be of about equal value with formalin and water mixed at the rate of one to ten, both as to attractive power and killing effects. The addition of sugar to the alcohol mixture gave a more marked increase in the attractive power than did the addition of sugar to the formalin mixture. Beer and alcohol did not make an attractive mixture, while the addition of bread to alcohol and to alcohol mixtures increased the attractive power

even greater than did the addition of bread to formalin and to formalin mixtures.

Bichromate of potash solutions gave practically no results either in the tests of its attraction or of its poisonous qualities.

Cobalt gave variable results in the tests but appeared rather peculiarly attractive when used with bread and in one instance exhibited better killing effects than formalin.

Sweet milk without addition of other material seems to have little if any advantage over sour milk in the point of attractiveness to flies. Combined with bread sweet milk was strikingly attractive but not so much so as were formalin or alcohol mixtures used with bread.

Beer was found to be a very attractive bait for flies under certain conditions. As already mentioned it combines readily with formalin but not with alcohol. Fresh beer, contrary to the common idea, was found to be far more attractive than stale beer.

Bread added greatly to the attractiveness of various liquid fly foods and poisons.

Wheat bran was found by the experiments here recorded and others to be inferior to bread as a fly bait.

Overripe or decayed banana was found to be superior to ordinary ripe banana and to both good and decayed oranges and apples as a fly bait.

Commercial dried blood moistened with water was found in the experiments to have attractive value greater than fresh and decomposed meat or fish. It is noteworthy that decomposed fish was found to be much less attractive to house-flies than fresh fish. Blue bottle flies and other species of the so-called flesh or meat flies were attracted to these "animal matter" baits, but only the true house-fly is herein considered.

Contrary to expectations cane syrup and sugar and water were found to have relatively low attractive value when used without other materials.

The value of sticky fly paper was very materially increased by exposing small amounts of attractive baits on the center of each sheet. The tests show that a thin slice of overripe or decayed banana makes an inoffensive and effective bait for this purpose.

Mr. T. J. Headlee: In the house-fly campaign in the City of New Brunswick, N. J., "Hodge Fly traps" were placed on garbage cans. Very few house-flies were caught but large numbers of green and blue bottle flies were secured. We experimented with various kinds of bait. Milk and bran bait is the best we have found, but we did not

go into such extensive tests as have been outlined by the speaker. Large cylindrical traps used on the college farm caught immense numbers of flies. Although we caught twelve to fifteen quarts each week on the college general farm, we could not discover that the destruction of this number produced any appreciable diminution. It seems to us that traps are almost useless in such campaigns, and that the elimination of breeding places is all-important. In the city fly control work this must be brought about by the establishment and maintenance of a good sanitary police force.

MR. J. G. SANDERS: Of all the baits I have used for house-flies, the best I have discovered is milk and formalin. It is more effective if milk is allowed to sour before the formalin is added.

MR. Z. P. METCALF: In my laboratory I have a sink about twelve feet long from which the water does not drain properly. Vessels containing formalin solution are often exposed in this room and on days when the sink becomes dry the flies drink the formalin from these vessels and are killed. When the water remains in the sink they do not touch the formalin and no mortality results. In West Raleigh the people are able to control the house-flies by not giving them access to water.

In another room where there was a drinking fountain flies were very troublesome and it was impossible to kill them with the milk and formalin mixture. After the fountain was removed large numbers were destroyed by using this mixture.

PRESIDENT P. J. PARROTT: We are greatly favored this morning by the presence of Dr. L. O. Howard who will present the next paper, entitled "The Education of the Entomologist in the Service of the United States Department of Agriculture."

THE EDUCATION OF THE ENTOMOLOGISTS IN THE SERVICE OF U. S. DEPARTMENT OF AGRICULTURE

By L. O. HOWARD

This paper has no connection with the excellent series of papers presented before this Association on the training of an economic entomologist, since it does not in any way attempt to point out the necessary lines of education for one entering the government service. It is simply an effort to indicate the educational institutions at which the men who have entered the service received their training. I have the facts about 260 of these individuals, and, entering into the matter without any preconception of the result, I must confess to much surprise at the great number of institutions represented (64 American

colleges and universities) and at the distribution of the individuals among these institutions.

In the history of the service there have been but four heads. Glover, the first entomologist, received no university education, but was trained in art at Munich, just as was Frederick Knab of the present Bureau force at a much later date. Riley, the second incumbent of the office, was sent as a young boy from England to boarding schools in France and in Germany (at Dieppe and Bonn) but came to this country at the age of seventeen without having any real college training. Comstock, the third entomologist, worked his way through Cornell University, graduating with the class of 1874. The present incumbent was one of Comstock's earliest students and graduated with the class of 1877. Comstock held the office for two years only, and was succeeded in 1881 by Riley, who also preceded him, the present incumbent succeeding Riley in 1894.

The growth of the service was comparatively small down to 1900, and it is only within the last dozen years that there have been great additions to the force.

In the tabulation which I have made I have taken into consideration only those men of sufficient scientific attainments to be capable of good research work, and have not included men like Osborn, Hine, Bruner, Newell and others who, while holding other positions, have been salaried collaborators of the Bureau of Entomology. The following tables give the colleges in which these men studied. It will be noticed that the Massachusetts Agricultural College and Cornell University have the largest representations, the Ohio State University coming third, and the University of Colorado fourth. It should be stated that all of the men indicated by the tables have come together in the Bureau on the strength of their qualifications and their availability. When a good man could be engaged, the question as to what college or what section of the country he might come from has had very little weight, except that on certain special investigations in certain parts of the country, where men were available who understood local conditions and who knew the local people, these have been engaged. Thus 11 out of the 20 men engaged on the scientific aspects of the moth work in New England have studied at the Massachusetts Agricultural College, some California men have been engaged for California investigations, some from Utah and neighboring states for the alfalfa weevil and some southern men for the cotton boll weevil and other Southern insect problems. The United States Civil Service Commission now furnishes most of the men through its examinations and these are held all over the country. The papers are marked without personal knowledge of

the individual or of the college at which he has been trained, and the selections are therefore perfectly unbiased.

The teaching of entomology at Cornell and at the Massachusetts Agricultural College was begun at an early date; these departments of these institutions have been well supported, and these facts account in the main for their larger representation on this list. The University of Illinois is represented by but five, yet this does not mean that Forbes and his assistants have not been training many good men. Professor Forbes's activities have been so extended that he has been able to employ himself most of his best graduates, while many others have gone out into college and experiment station work.

It will be noticed that Harvard has been represented by seven. Two of these were from the early days of Doctor Hagen, namely, H. G. Hubbard and B. P. Mann; a third, P. H. Timberlake, took post-graduate work at Harvard after graduation from Bowdoin; a fourth, E. S. G. Titus, took his doctorate under Wheeler of the Bussey Institution quite recently, the fifth, R. W. Glaser, is now at work at the Bussey Institution on insect diseases and is studying for the Bureau the wilt disease of the gipsy moth, and the remaining two, Messrs. G. E. Clements and W. S. Munro went from Harvard to the Yale Forest School before entering the service. Now that Wheeler is at the Bussey Institution, it is safe to predict that the services of men from Harvard will be sought for by the government and the states in the future.

It is shown that twelve men have studied at European institutions of learning, and also that eighteen have, like Glover and Riley, had no college education. It is especially noticeable with those who have not been to college that many of them seem not to have suffered in the least from the lack of college training, since this category includes such leaders as F. M. Webster and A. D. Hopkins, such excellent systematists as D. W. Coquillett, W. H. Ashmead, C. H. T. Townsend, and O. Heidemann, and such capital observers as T. Pergande, H. S. Barber, A. Koebele, J. D. Mitchell and F. C. Pratt.

Several of the men have studied at more than one college, and in such cases he is credited as a unit to each of the colleges.

The leaders of the different sections of the work of the Bureau of Entomology are distributed as follows: Marlatt, now chairman of the Federal Horticultural Board, in addition to ranking next to the chief in the Bureau, graduated from the Kansas State Agricultural College; Webster and Hopkins, as has just been pointed out, educated themselves; Chittenden graduated at Cornell; Quaintance received his bachelor's degree from the Florida Agricultural College, his master's degree from the Alabama Polytechnic Institute, and later took post-

graduate work at Cornell; Hunter received both his bachelor's and master's degrees from the University of Nebraska; Phillips took his bachelor's degree at the Allegheny College and his doctorate at the University of Pennsylvania; Burgess is a Massachusetts Agricultural College man.

A special word of commendation should be said of the six able men who have come into the service from the Ontario Agricultural College at Guelph, Canada.

The occurrence on the list of five men from Yale might at first sight seem strange. One of them, C. R. Dodge, was Glover's only assistant in the seventies, and graduated from Yale in the class of 1874. The other four are readily accounted for by the fact that they attended the Yale Forest School and are engaged in forest insect investigations.

Those who have had any experience with the U. S. Civil Service Commission and the laws which govern it will understand very well what is meant by state apportionment, and it often happens that the government is unable to get the services of the men who have passed the highest in examinations, owing to the fact that the states from which they come have their quotas in the service already filled. From every viewpoint except the one of practical politics this is unfortunate. It may be granted, however, that so far as the entomological service is concerned it has not worked very badly, and it is true that the man who passes the best examination is not necessarily the best man in, say, a field laboratory.

I remember once in the early days of the investigations of the cotton boll weevil I was asked by a member of the Committee on Agriculture of the House of Representatives "Why do you not employ Southern men on this investigation—men familiar with the cotton crop and with everything connected with it?" My reply was to the effect that the Southern States did not educate men in entomology. That condition, however, is changing, and the following statement of the geographic distribution of the men and the colleges which they represent will indicate that there is a pretty fair representation on the force of all sections of the country. The statement is as follows:

From colleges in the Eastern States	113
From colleges in the Central States	63
From colleges in the Western States	31
From colleges in the Southern States	23
	230

It will be readily understood that with some of the institutions like Beloit, Bucknell, Bowdoin and Dartmouth colleges and some of the others, the men did not go to them for training in entomology, but for a

general education, their real training having come from outside interest in the subject and from experience after joining the Bureau force. And this suggests the truth that, no matter how sound a man's college training has been, he begins to learn the things that count most only after he has got out into the government service or into that of one of the states. There is room for improvement in courses in entomology in most of our institutions, and our teachers in entomology, as in other branches, notably in the thirty-seven different kinds of engineering science, should constantly study the markets for the brains of the men they are training. This is an important reason why these meetings of ours, not only of the Association of Economic Entomologists, but of the great body of scientific and practical men who come together each year under the auspices of the American Association for the Advancement of Science, are so valuable, since they bring the teachers and the laboratory men and the field men together; and if the curricula of educational institutions are not frequently changed as a result of information gained at these meetings they should be.

The time is coming before many years when the best education even in economic entomology will be gained only by supplementary traveling scholarships. Down to the present time Dr. Andrew Carnegie, among his many great benefactions to humanity, has been responsible for the only traveling scholarships of this kind. Through the Central African Research Committee and the Imperial Bureau of Entomology he has brought to this country from England Messrs. A. Rutherford, E. H. Strickland, G. H. Grosvernor, C. W. Mason, M. A. MacGregor and A. H. Ritchie, and from British Guiana, Mr. G. E. Bodkin. Through the writer, he has brought over Dr. K. Escherich from Germany and Dr. Paul Marchal from France. All of these have come to America because of American prominence in this work of ours. None of us have been sent to other countries to study economic entomology because we have in general the best teachers at home. But the time is coming when other countries will come to the front in this direction and when our most promising young men will be sent to foreign teachers to round out and complete their training.

When last summer, with Marchal, I visited the Bussey Institution of Harvard, Cornell, Chicago, Illinois, California, and Stanford, I was enormously impressed by the great advantages which the student of these days has over the student of twenty years ago, but it is certain that, great as these educational advantages in our line are today, those of tomorrow will be vastly greater.

Nevertheless we must look at Riley and Hopkins and Webster, and conclude that while education educates, it's the man who achieves.

Colleges Arranged Alphabetically Showing Students Who Have Served in the Bureau of Entomology

Alabama Polytechnic Institute	2
Allegheny College	2
Beloit College	1
Bowdoin College	1
Bucknell College	1
Clark University	2
Clemson College	1
Colorado State Agric. College	10
Columbia University	2
Connecticut Agric. College	1
Cornell University	26
Dartmouth College	1
Delaware Agricultural College	1
Florida Agricultural College	2
Harvard University	7
Iowa State Agricultural College	1
Jefferson Medical College	1
Johns Hopkins University	1
Kansas State Agricultural College	5
Kentucky State University	1
Maine State College of Agriculture	1
Maryland Agricultural College	4
Massachusetts Agricultural College	36
Michigan Agricultural College	7
Mississippi Agricultural College	3
New Hampshire Agricultural College	2
New Jersey Agricultural College	1
North Carolina Agricultural College	1
Ohio State University	17
Ohio Wesleyan University	1
Oklahoma Agricultural College	1
Ontario Agricultural College	6
Pennsylvania State College	5
Pomona College	2
	156
Forward	156
Randolph-Macon College	1
Stanford University	7
Texas Agricultural College	2
University of California	1
University of Chicago	2
University of Colorado	1
University of Idaho	2
University of Illinois	5
University of Indiana	1
University of Iowa	4
University of Kansas	5
University of Louisiana	2
University of Michigan	1
University of Minnesota	2
University of Nebraska	7
University of Montana	1
University of Nevada	1
University of North Dakota	1
University of Pennsylvania	6
University of South Dakota	1
University of Tennessee	2
University of Texas	2
University of Utah	3
University of West Virginia	2
University of Wisconsin	1
Utah Agricultural College	2
Virginia Polytechnic Institute	4
Washington State University	2
Washington University (St. Louis)	1
Yale University	5
American institutions	233
Foreign institutions	12
No colleges	18
	263

Colleges Arranged in Numerical Order of Representation in the Bureau of Entomology.

Massachusetts Agricultural College	36
Cornell University	26
Ohio State University	17
Colorado State Agricultural College	10
University of Nebraska	7
Harvard University	7
Michigan Agricultural College	7
Stanford University	7
Ontario Agricultural College	6
University of Pennsylvania	6
Kansas State Agricultural College	5
Pennsylvania State College	5
University of Illinois	5
University of Kansas	5
Yale University	5
Maryland Agricultural College	4
University of Iowa	4
Virginia Polytechnic Institute	4
Mississippi Agricultural College	3
University of Utah	3
Alabama Polytechnic Institute	2
Allegheny College	2
Clark University	2
Columbia University	2
Florida Agricultural College	2
New Hampshire Agricultural College	2
Pomona College	2
Texas Agricultural College	2
University of Chicago	2
University of Idaho	2
University of Louisiana	2
University of Minnesota	2
University of Tennessee	2
University of Texas	2
University of West Virginia	2
Utah Agricultural College	2
Washington State University	2
	206
Forward	206
Beloit College	1
Bowdoin College	1
Bucknell College	1
Clemson College	1
Connecticut Agricultural College	1
Dartmouth College	1
Delaware Agricultural College	1
Iowa Agricultural College	1
Jefferson Medical College	1
Johns Hopkins University	1
Kentucky State University	1
Maine College of Agriculture	1
New Jersey College of Agriculture	1
North Carolina College of Agriculture	1
Ohio Wesleyan University	1
Oklahoma Agricultural College	1
Randolph-Macon College	1
University of California	1
University of Colorado	1
University of Indiana	1
University of Michigan	
University of Montana	1
University of Nevada	1
University of North Dakota	1
University of South Dakota	1
University of Wisconsin	1
Washington University (St. Louis)	1
	233
Foreign institutions	12
No college	18
	263

President P. J. Parrott: The next paper will be presented by Dr. C. Gordon Hewitt, entitled "Further Observations on the Breeding Habits of the House-fly and its Control."

FURTHER OBSERVATIONS ON THE BREEDING HABITS AND CONTROL OF THE HOUSE-FLY, MUSCA DOMESTICA

By C. Gordon Hewitt. D. Sc., F. R. S. C. *Dominion Entomologist, Ottawa*

The following account of certain investigations carried on during the past summer (1913) is of a preliminary character. It was considered desirable to communicate to the Association an interim report of this nature, primarily with a view to drawing the attention of other workers to the need of experimental work along similar lines. In so important a public problem as the control of house-flies, it is most desirable that the assistance of as many workers as possible should be enlisted, especially in a country containing so varied climatic, econnomic and other conditions.

Probably no entomological subject is now more popularly discussed than house-fly control, and as one who has, during the past eight years, devoted more attention to this subject than to any other entomological problem, I am bound to confess that in the matter of control measures there is still much to learn and we are far from having solved the basic problem of control, namely, the prevention of breeding. I am not referring particularly to the question of the construction of fly-proof receptacles for stable-refuse and other fly breeding substances, but to the use of insecticidal substances under conditions which prohibit the taking of other precautions and render desirable the adoption of additional remedial measures.

It is in regard to control measures under rural conditions that we are most deficient in knowledge. For many reasons the prevention of breeding under urban conditions is, I believe, more subject to control. Civic authorities can insist on stables being constructed on certain approved lines, on the segregation of stables, a most important policy, on stable-refuse and garbage being stored according to prescribed methods, on the periodic removal of these breeding substances and so forth. All of which tend to reduce the problem to simple terms, though I should be the last to deny the inherent difficulties. Under rural conditions, however, the problem is different and it should be hardly necessary to indicate the importance of house-fly control in the country. One aspect alone, namely the possibility of milk contamination, and our milk supplies will always originate in the country, is sufficiently serious to warrant the greater attention to fly control

measures in rural districts. In such districts conditions are not so easily controlled by health and other authorities, though very efficient control could be established by means of regulations governing the supply of milk to cities and towns requiring the inspection of farms and dairies. Nevertheless, we are faced with the problem of house-fly control under rural conditions and we must examine it.

The farmer, if he does not store his stable refuse in fly-proof receptacles, will probably require a cheap and efficient insecticide. In addition he will usually ask what effect will the application of an insecticide have on the fertilizing of the manure. These are the problems we are called upon to solve and it was with a view to obtaining further data on the comparative value of insecticides in the control of house-flies under rural conditions and the effect of such treatment on the fertilizing properties of the manure that the special investigation which I commenced during the past summer was undertaken.

A number of investigators have previously carried on experiments along these lines, among whom may be mentioned Howard at Washington, Forbes in Illinois, Herms in California, and Newstead in England, but I feel sure that they would be the first to agree with my contention that the problems, as I have briefly indicated them, are by no means solved and that much more experimental work is required. There are two distinct problems which the study of the comparative value of the insecticides involves, namely, their insecticidal value and their effect on the fertilizing properties of the manure. The latter problem must of necessity be studied largely if not entirely by the agricultural chemist, and as the study of the comparative manurial values has not been undertaken in the course of the past season's work but will be prosecuted, I hope, next year, I shall devote myself to a consideration of the first of these problems. I would impress upon other workers, however, the great desirability of studying the effect of the insecticides on the manure as the farmer requests information on that point.

In passing, I should not omit to refer to a frequent recommendation which is made to farmers as a means of prevention, namely, that the manure should not be stored in heaps but should be carted away immediately and spread. Where this can be done it is, of course, the simplest method of procedure; apart from that fact it has the additional advantage of being the best policy from the point of view of manurial values. Extensive experiments in Canada and the United States have demonstrated the advantage of spreading the manure over piling it. This, however, is by the way.

In order to judge the relative values of different insecticides it is necessary to decide upon a means of comparison. In making this

choice there are two alternatives, namely, either to count the number of dead as compared with the living larvæ in the treated manure, or to count the flies emerging after treatment. In previous work of this nature the former standard has been employed as a rule. It has a serious defect, however, namely, that the portion of treated manure selected, presuming a fair amount has been treated, may not be typical of the whole; in fact my experiments have shown that it would be extremely difficult if not impossible to select an average sample. To this point I shall refer later. In my opinion the only satisfactory basis of comparison is the number of adult flies which emerge from the whole amount of the manure treated. The experiments about to be described were arranged with that object in view.

Methods

It was decided to use a cubic yard, that is twenty-seven cubic feet of manure, as the amount of manure to be treated and the number of flies emerging from a cubic yard of untreated manure would be used as the standard of comparison. As experience demonstrated the actual quantity of manure was a little less than twenty-seven cubic feet owing to the sinking of the manure. In spite of the cubic yard being heaped up it settled to a depth at the sides of two feet six inches on the average, thus giving approximately twenty-two cubic feet of manure after settling.

To contain the manure wire enclosures (Plate 9) were constructed of strong one-inch galvanized poultry wire supported by wooden stakes and cross-pieces at the top which was open. The stakes were driven into the ground until three feet of wire remained above ground.

The horse manure, which was mixed with an average quantity of straw used in the stables, was carted straight from the stable and thrown into the wire enclosures and trodden down as it was thrown in to obtain a fairly compound and typical manure heap. The top of the pile was made higher than the enclosure to allow for the settling which took place in spite of the packing. The sandy soil was piled up around the base of each heap to provide accommodation for the pupation of the larvæ.

Six such piles of manure were used. In some cases they were left for two days to allow the flies to oviposit, in other cases, for example, where chloride of lime was used, they were treated immediately after the enclosures had been filled. After exposure for two to three days and treatment with the insecticides the heaps were covered with wooden covers as shown in plate 9. These covers were made sufficiently large to leave a space of about six inches all around the wire enclosures when they were covered. Two holes were provided in the top for wire balloon fly traps to capture the flies as they emerged.

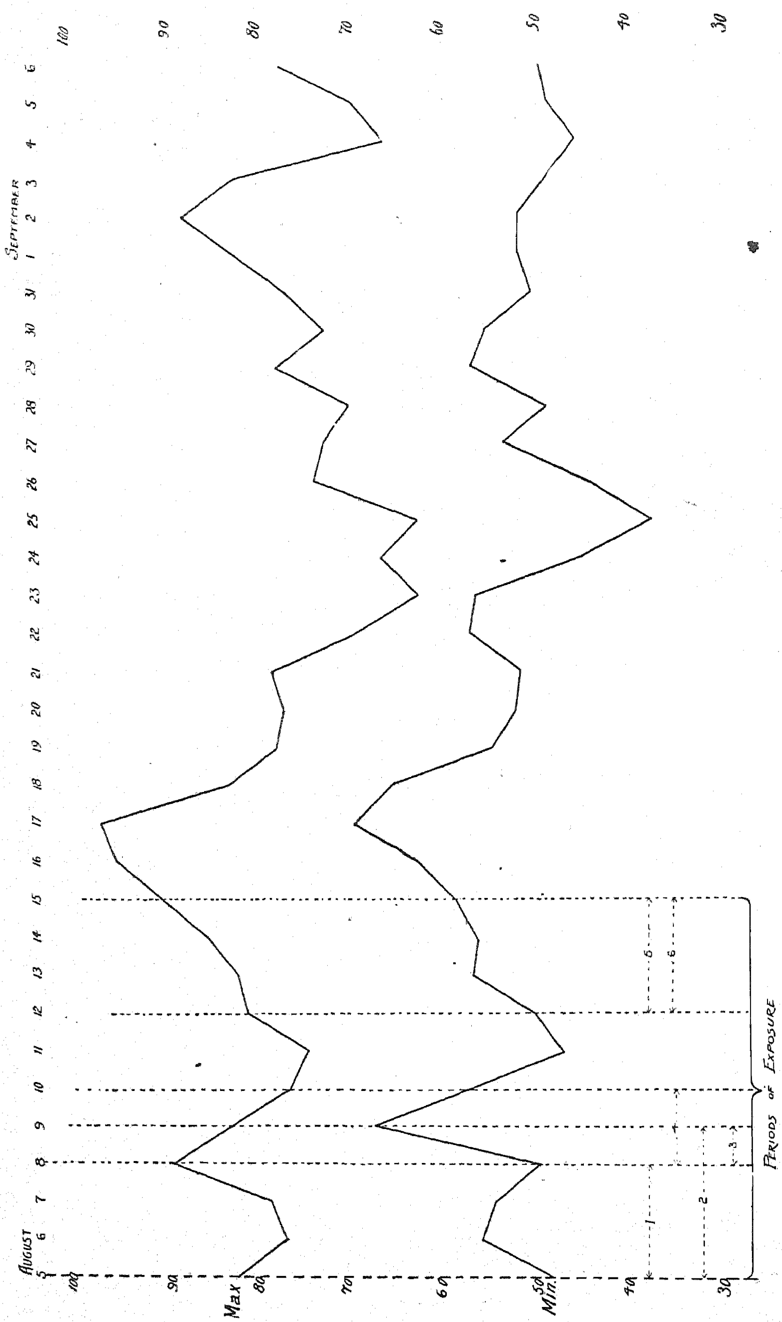

Fig. 20. Maximum and minimum temperature during experiments

It was not long before experimental results were obtained but these were not of the nature which I had planned to secure. In spite of the fact that the lower edges of the wooden covers had been sunk in trenches and the soil piled round, it was found that some of the larvæ tunnelled beneath the cases and pupated in the soil piled outside the case with the result that flies began to emerge outside where provision had to be made for them. In this way a few hundred flies escaped from each of the first two or three experiments, but not sufficient, I think, to materially affect the general results. Accommodation was immediately provided for the reception of these wanderers by covering the piled up soil round the outside of the wooden case with cheese cloth, as shown on plate 9 and the exit at the front led into a wire balloon fly-trap. After this no further trouble was experienced, but the circumstance threw additional light on the pupating habits of the larvæ to which I shall refer later (see Pupation).

The emerging flies were caught in the wire traps and were counted once or twice daily as circumstances demanded. Heat was used as the means of killing them. I wish to acknowledge my indebtedness to my assistants Mr. Germain Beaulieu, and Mr. Sydney N. Lord who carried out the work of counting the individual flies.

Experiments

Six series of experiments, Nos. 11 (1) to 11 (6) were carried out and the following is a summary of the series:

Exp. No. 11 (1). Untreated. Manure piled August 5th. Covered August 8th on which date second stage larvæ were found very numerous immediately beneath the surface.

Exp. No. 11 (2). Iron sulphate treatment. Manure piled August 5th. Pile sprayed with iron sulphate (2 pounds in 1 gallon of water) on August 8th, on which date many second stage and a few third stage[1] larvæ were found in surface layer. Four gallons were applied to the top and sides of heap with a hand spray pump using a coarse nozzle. The vertical sides of the heap made it more difficult to thoroughly drench the manure on the sides. Pile covered August 9.

Exp. No. 11 (3). Chloride of lime; surface treatment. Manure piled August 8th. After piling, 3 pounds of chloride of lime were sprinkled over the top and sides of the heap, the sprinkling of the vertical sides was difficult and not entirely satisfactory. On August 9th living third stage larvæ were found within an inch of the surface

[1] As the manure in each case lay in the stable for two or three days before being hauled out and piled in the wire enclosures a certain number of eggs were deposited before hauling, in spite of the stable being screened. But this fact would not vitiate the results of these experiments.

immediately beneath the chloride of lime in spite of a thunder-storm and heavy rain which should have carried the chloride of lime in solution through the upper layers. Covered pile same day, August 9.

Exp. No. 11 (4). Zenoleum treatment. Manure piled August 8th. August 9th larvæ in third stage were found very numerous immediately below the surface of pile. Sprayed with zenoleum (3 ounces to 1 gallon of water) same date, using 4 gallons of the solution. Larvæ immediately beneath the surface were killed and about 20 minutes after spraying larvæ were found emerging on to the top of the manure, no doubt to die. An hour after the heap had been sprayed torrential rains fell and as a result the dilution of the insecticide would probably be affected. Pile covered August 10th.

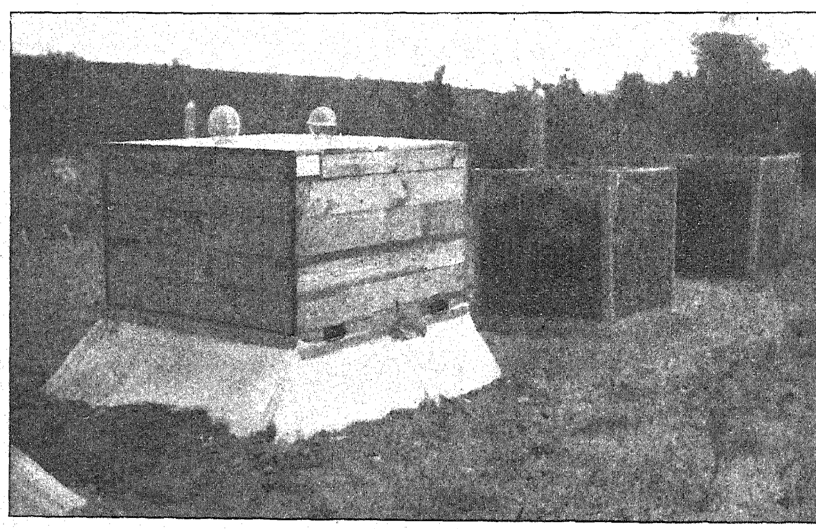

Fig. 21. Covered and uncovered manure piles used in the experiments

Exp. No. 11 (5). Chloride of lime; mixed treatment. Manure piled August 12th. As it was being thrown in the enclosure chloride of lime was lightly scattered over the top and on the sides, $4\frac{3}{4}$ pounds of the chemical being used on the cubic yard of manure. This manure had lain in the stable from 1 to 3 days. Pile covered August 15th.

Exp. No. 11 (6). Kerosene emulsion treatment. Manure piled August 12th. On August 15th third stage larvæ found in upper layers. Pile sprayed same day, August 15th, with kerosene emulsion 1 in 9 strength; $4\frac{1}{2}$ gallons used for the whole pile. This pile contained a little more straw than other piles. Pile covered August 15th.

Emergence of Flies

The following table summarizes the results of these experiments which have been arranged in order according to the number of flies emerging from the various piles.

EXPERIMENTS WITH LARVICIDES

Treatment	Number of Flies Emerged		Total	Experiment Number
	Top Cages	Bottom		
Control, Untreated.......	8,729	4,603	13,332	11 (1)
Zenoleum...............	229	7,811	8,040	11 (4)
Iron Sulphate...........	5,546	2,304	7,850	11 (2)
Chloride of Lime (surface)	857	5,086	5,943	11 (3)
Chloride of Lime (mixed).	901	3,726	4,627	11 (5)
Kerosene Emulsion.......	832	2,649	3,481	11 (6)
	17,094	26,179	43,273	

From the foregoing experiments kerosene emulsion appeared to be the most effective insecticide. I am inclined to believe, however, that the greater proportion of straw in this experiment, No. 11 (6), affected the results, and I should be inclined to prefer the chloride of lime treatment pending further results, especially as kerosene emulsion is considered, I believe, by chemists to affect the manurial values of the stable refuse.

These preliminary results, however, are not given for the purpose of drawing conclusions as to the best insecticide, but rather to indicate a method whereby such results may be obtained.

Pupation

Among the miscellaneous observations made during the past season's work, the following may be mentioned: It was found that the mature larvæ generally left the manure heap to pupate and buried themselves in the sand some distance away from the heap. That the majority of the larvæ travelled some distance before pupating is demonstrated in the following table in which it is seen that in the aggregate a greater number of flies were captured in the *bottom* cages, that is, the cages attached to the cheese cloth outside the wooden covers, in which cages the flies emerging from pupæ outside the wooden covers were captured.

In the cages on the top of the wooden covers, referred to as the top cages, the flies emerging from pupæ within the sides of the wooden covers were captured and these were less in number than the flies emerging from pupæ outside the wooden covers.

Larvæ were found pupating at a distance of two feet from the manure pile and at a depth of nine inches.

Temperatures of Manure and Their Significance

In the course of these experiments some significant observations were made on the temperature of the manure piles. The heating of the freshly piled manure is a matter of common knowledge and observation, but I have not seen any reference to its relation to the breeding of house-flies beyond the general statement that the higher temperature accelerated the development which my own experiments carried out some years ago under controlled incubator conditions demonstrated. Newstead found that at 100° F. the larvæ were uncomfortable and left the manure. In incubator experiments I found that a temperature of 104° F. was too great for the larvæ and anything above that roasted them alive.

If we examine the temperature of a pile of manure taken at a time when it is fresh, attractive to flies and inhabited by larvæ, the results are somewhat surprising and significant. The following are the temperatures which were taken in connection with two of the experiments:

Expmt. No.	11 (1).	11 (4).	11 (5).
Date	August 8.	August 9.	August 15.
Length of time manure exposed	3 days.	2 days.	2 days.
Atmospheric conditions	Sunny, cool wind.	Oppressive, alternately sunny.	Oppressive, sunny alternately.
Air temperature	86° F.	78° F.	103° F.
Temp. on surface of manure	97° F.	87° F.	—
Temp. 1 in. below surface	—	106° F.	—
Temp. 4 in. below surface	156° F.	145° F.	—
Temp. 6 in. below surface	158° F.	—	—
Temp. 10 in. below surface	164° F.	—	160° F.

From the above temperature records it will be seen that at no great depth from the surface of the manure piles the heat was too great to permit the existence of the larvæ, and this fact was supported by observation. On the top of the pile the larvæ were only living in the surface layer, that is, the habitat was *peripheral* and the excessive internal heat due to fermentation becomes practically a larvicide.

It is evident that in a well-packed manure heap, I am not speaking of small or loosely piled heaps, that only the peripheral region is infested by the house-fly larvæ, and that they do not, as a rule, penetrate deep into the central regions. In loosely piled heaps it would be possible for them to penetrate more deeply. The cooling of the whole heap might conceivably permit the deeper penetration of subsequent broods, but against this should be set the fact that the outside region

of the heap has by this time become less attractive to the flies owing to exposure and the fact that larvæ have already worked over it.

Reference was made earlier in the paper, in discussing the relative merits of counts of larvæ or of flies emerging as standards of comparison in judging insecticide values, to the difficulty of obtaining a fair sample of a manure heap. This fact is emphasized by the foregoing observations. Further, calculations have been made of the number of flies which might be produced from larvæ in a manure pile of a given size based upon estimates of the number of larvæ occurring in a pound of manure. Such estimates are obviously far from accurate, and while it may be a good policy to impress the lay mind with potential dangers of a heap of stable refuse, we should not do so at the expense of veracity. I am ashamed to admit that our knowledge of the breeding habits of the house-fly in manure piled under various conditions is by no means as complete as it should be and it is very desirable that other workers should make observations on such habits as the conclusions may prove of no little value in aiding the agriculturalist in the problem of the control of breeding places. If the conclusions in regard to the peripheral breeding habits of the fly in well-piled manure are correct, the advantage of storing in concrete and wooden chambers receives material support.

Mr. L. O. Howard: Experiments have been carried on in Washington and New Orleans of a similar character to those given by Doctor Hewitt and I would like to ask Mr. W. D. Hunter if he will explain what has been done in this direction.

Mr. W. D. Hunter: This year Doctor Howard inaugurated a series of house-fly experiments in Washington, almost parallel with Doctor Hewitt's. They grew out of the idea that Doctor Howard had had for several years that the whole subject of the treatment of the breeding places of the house-fly had not been sufficiently investigated. The same idea Doctor Hewitt has mentioned occurred to Doctor Howard, that is, the necessity for basing experiments upon consideration of the effect of applications on the manure. At that juncture Doctor Howard called upon the Bureau of Chemistry, and coöperative experiments were begun, the Bureau of Entomology looking after the entomological part of the work, and the Bureau of Chemistry to determine the effect of the different applications upon the chemical composition of the manure, and a bacteriologist was brought in at the same time to determine the activity of the bacteria of the manure. Without knowing, as far as I am aware, of the plans that Doctor Hewitt

was putting into operation in Canada, we devised a series of cages very similar to his. There was a double wall provided to prevent infestation by eggs that might be deposited on the outside by flies, that would be attracted by the odor of the manure. The cages were supported on four legs about 6 inches high. Part of the apparatus was a galvanized iron pan, in which the seepage from the deposit could be collected for chemical examination.

Doctor Hewitt referred to the fact that in most of the experiments of this kind that have been performed only one of the two important series of observations had been made. In some cases the manure has been examined to determine the effect on the fly larvæ. In such cases the determination of the number of flies emerging was overlooked, and in the other case the number of flies emerging would be determined, and the effect on the larvæ would be overlooked. Consequently, in our series of experiments we took both of these factors into consideration. On one side of these cages a small opening was provided. Through that opening, from time to time, after the manure was placed in the cage, small samples were extracted. A portion of the samples was used by the chemist to determine the effect of the application, and at the same time the exact mortality of house-flies was determined. These observations were made in more or less extensive series, so that the results could be averaged, and at least an approximately true index of the situation obtained. The number of adult flies emerging was watched in practically the same fashion as Doctor Hewitt's experiments. Wire fly-traps were placed on top, and the exact number was determined. We, therefore, had two methods of checking up the results; first, the actual examination of the larvæ in the manure to determine the mortality, and, second, the actual emergence of adults. We had the same difficulty that Doctor Hewitt encountered in obtaining a uniform infestation. We found no very satisfactory method of obivating that. We did what we could towards obviating it by mixing the material very well, exposing it first, then having it shovelled up, so as to approximate uniformity of infestation. I should say in this connection also that liberal allowance was made for control cages, that is, every time one of these series of experiments were started, three or more cages were used, in which the manure was not treated. In those cages the same examinations were made as to deaths and flies emerging. In that way, allowance was made for the normal mortality in the manure.

We had planned to use all of the substances that had been recommended for fly control, and any others, that might be suggested by the chemist. We used salt, borax, copper sulphate, iron sulphate, a number of proprietary substances, creosote, etc. The series of experi-

ments were so interesting, and the results so definite that, as the fly season was drawing to a close, Doctor Howard and Doctor Alsberg arranged to transfer the whole work to the City of New Orleans, where the flies would be active for perhaps two months longer. Certain series of experiments were repeated in the hope that results would become so definite that something could be published and used throughout the country at the beginning of the next fly season. Doctor Cook, of the Bureau of Chemistry, and Mr. Hutchinson, my associate, have just completed that second series of experiments in New Orleans. Mr. Hutchinson is here today. In a very short time we expect to place the results on record.

In connection with this investigation we undertook to work out some of the points in the life history of the fly, on which our information has been very meagre, as has been pointed out by Doctor Hewitt in his noteworthy work on the house-fly and Doctor Howard in his recent book. One of these points particularly was the duration of the period between the emergence of the adult flies and their attaining sexual maturity, that is, the pre-oviposition period. I think all the members of the Association are familiar with the basis of the so-called Hodge plan of controlling flies. In brief, Doctor Hodge's plan is to ignore, at least in a large part, the breeding of flies in stable manure, and devote the attack against the adults. That is the result of some experiments performed some years ago by Doctor Hewitt. He found the pre-oviposition period ran as high as ten to fifteen days. During that time there was no danger of depositing eggs, but the adult flies are going about getting food.

We were very much interested in getting complete data. Mr. Hutchinson would take a number of flies, place them in a jar with some food material that would be suitable, and would leave them in a certain cage for 24 hours. Then they would be taken out and the cage recovered, and observations made later as to whether any eggs had been deposited or any larvæ could be found. In a second cage the flies remained there 48 hours, and so on up to an indefinite number of 24-hour periods. In this way we hoped by the repetition of the experiments to obtain absolutely accurate information on this point. The results have not been assembled completely at this time, but the indications are very plainly that this pre-oviposition period is much shorter than the preliminary experiments of Doctor Hewitt had indicated. That emphasizes the importance of the point brought out by Doctor Headlee—the absolute importance of directing efforts against the place where they might be breeding.

Just one other point. Doctor Headlee and Doctor Hewitt have both referred to the limited distribution of the fly larvæ in the piles of

manure. In connection with this series of experiments at the Arlington farm, Mr. Hutchinson was astonished one day to find that a large number of his larvæ were escaping. He began to investigate the matter. By examining many piles of manure near Washington he found a concentration of larvæ and pupæ in the peripheral ring near the outer surface. Immediately he considered the factors of moisture and temperature, that might be instrumental in bringing about this condition. The result of the observations of Mr. Hutchinson led him to the belief that moisture is more important than temperature. In fact, he has performed a series of experiments, in which he has regulated practically the location of the pupæ by the administration of water. This led to one point, that may be of great importance. He has found that, where the manure piles are completely saturated with water, the larvæ will make their way outside. The instinct of the larvæ is to obtain a location where there is an optimum of conditions and where the adults can make their exit. A practical application in a stable would be to throw the manure upon a frame work and keep it saturated with water. By that system the experiments show the larvæ will all fall through the bottom to the floor. In the case of a cement floor, it would be possible to flush them into the drain, or dispose of them some other way. On a farm the manure might be placed on a platform and the larvæ forced by the application of water to make their way out to be eaten by the chickens.

I would like to congratulate Doctor Hewitt on this very important work that he has done. I think that all the members of the Association think that the high standard, that he set, when he wrote the book on the house-fly, has been maintained by the series of practical experiments, which he has described this morning.

Mr. C. Gordon Hewitt: A number of years ago when I carried on house-fly work, I was able to devote all my time to it. Now it is possible for me to carry it on only during spare time. I would urge Doctor Howard and his associates to continue to carry on these experiments as they are very important. With regard to the pre-oviposition period, the single series of experiments which I carried on in Manchester, England, gave but few results and were not intended to do more than to give general information. The mean temperature in Manchester, England, is much less than in this country, consequently the pre-oviposition period there would be longer.

In the experiments which I mentioned in my paper I found that flies were emerging on the outside of the wooden cages before the cheese-cloth bottom was attached. During the hot days the newly emerged flies crawled up on the outside of the cages and the males copulated with the females immediately. This shows that the female fly may

become fertilized very soon after emergence. In regard to the suggestion made by Mr. Hunter as to watering manure in stables, it would appear to me that this would have the disadvantage of decreasing the manurial value. We must be very careful about advising farmers to adopt a suggestion of this kind, for such a process would result in the loss by leaching of the soluble plant food in the manure.

Mr. Z. P. Metcalf: The town of Asheville, N. C., was one of the first to take up active work against the house-fly and is one of the few towns in the South that is continuing the work. The Board of Health required that manure be placed in tight receptacles and damped very slightly. While Asheville is not a flyless town, it is very much better in this respect than most towns of its size in the South.

President P. J. Parrott: We will now listen to a paper by Prof. S. J. Hunter, entitled

THE SANDFLY AND PELLAGRA, III[1]

By S. J. Hunter, *University of Kansas, Lawrence*

Summary of Progress

The work of obtaining evidence which would either confirm or refute the Sambon theory was continued this year under a special fund furnished by the Board of Educational Administration. The responsibility for the entomological side of the question rests with the author and the pathological side as manifested by the monkeys subjected to the bite of the sandfly rests with Dean Crumbine of the Medical School.

In this connection it may properly be noted here that since the publication of the last paper Harris has published an account of his results in producing pellagra experimentally in monkeys. Based upon his experiments, then, the monkey becomes a susceptible animal.

The two most important additions to our studies are fixed on the biting habits and morphology of the mouth parts of *Simulium vitattum*.

Heretofore, we experienced little difficulty in encouraging the sandfly to bite the patient but no extended attention had been given to the biting habits in nature.

Last August, owing to the limited water supply in the principle sandfly inhabited brooks, this part of the study was transferred to Madison River in southern Montana where all stages of the fly were unusually abundant. Here it was observed that the fly would bite the exposed parts and was more active on cool days while the temperature was below 70° F.

[1]For papers I and II see this journal, Vol. V, No. 1, Feb., 1912, pp. 61–63, and Vol. VI, No. 1, Feb., 1913, pp. 96–101.

Of special importance was the observation made by four members of the party that the bite of the fly was not always noticeable. For example, the writer sat through an entire evening meal in the tent with the sandfly biting on the face near the base of the nose. He was not aware of its presence there until informed at the close of the meal by his companions regarding the length of the time it had been there. The spot, reddened in this case, and was about the size of a flax seed.

It seems probable also that it succeeds in attaching itself to the host through its mouth-parts because, when once settled down to feeding, it sticks to the host and is not readily detached.

Biting is not uniformly painless as sometimes the insect would be detected by its first contact.

Regarding the morphology, Mr. W. T. Emery, who has been my graduate student assistant in this work, has a paper now in press dealing with that phase of the subject.

A second point to be here recorded is that the monkey, which we used all last year to receive inoculations from the sandfly and which received its last inoculation on December 22, 1912, as recorded in my previous paper, late in November last year began to show a marked stomatitis accompanied by a diarrhœa. She has continued to lose in weight and the color of the face is changing from the normal to a pale ashy gray.

This is simply a report of progress, and as the author views it, does not warrant any conclusion for or against the Sambon theory.

NOTES ON THE BIOLOGY OF DIPLAZON LAETATORIUS (FABR.)

By E. O. G. Kelly, *Bureau of Entomology, United States Department of Agriculture*

The published rearing of *Diplazon* (*Bassus*) *lætatorius* from *Syrphus* puparia are few. Ratzeburg mentions having reared it from *Syrphus balteatus* in 1848 (Ichneumon d. Forstinsect.). Mr. G. C. Davis also described the species in *Transactions American Entomological Society*, Vol. XXII, 1884, and following his description, he states that it is one of the most common and wide-spread species in Europe and America. Mr. Bignell, in *The Entomologist*, Vol. XVII, 1884, states: "On 3d of June, I bred this Ichneumon from a *Syrphus* larva, obtained last October in Oreston quarry, feeding on *Aphis jacobeæ*. By end of October it had changed to pupa and remained that way till above date." It is figured in the *Agricultural Journal of South Africa*, Vol. 6, No. 3,

Sept., 1913, with a legend underneath, stating that it was parasitic on Syrphids, no mention of it being made in the text.

In Kirchner's catalog of *Hymenoptera*, page 84, is recorded a note by Herr Tischkin that he reared *Diplazon lætatorius* from the larvæ of *Adimonia rustica* (a small Chrysomelid). In Ann. Ent. Soc. France for 1877, page 408, Giraud and Laboulbene record rearing *Diplazon (Bassus) lætatorius* from *Syrphus balteatus*.

Dr. F. H. Chittenden notes in circular 43, second edition, page 5: "The efficiency of the *Syrphus* flies is greatly impaired by the presence of a Braconid parasite (*Diplazon lætatorius*) which is sometimes very prevalent, almost exterminating its host in many fields." Doctor Chittenden told the writer that the species had occurred to him to be one of the very commonest insects and had thus escaped being published by him.

This species was reared from puparium of *Allograpta obliqua*, the larvæ of which were collected by Prof. F. M. Webster at Clymers Ind., May 17, 1886, and sent to Washington, and the same observer also reared *Diplazon sycophanta* from Syrphid puparia at Battleground, Ind., in 1889. It has been reared from Syrphid puparia on several occasions during recent years by members of the Bureau of Entomology, United States Department of Agriculture. Mr. V. L. Wildermuth reared adults from puparia at Yuma, Ariz. In a note on this species he mentions collecting three Syrphid larvæ, on April 23, 1912, feeding on *Aphis maidis*. They pupated April 24, 26 and 27, from these puparia adult *Diplazon lætatorius* issued on May 7, 9 and 12. Mr. H. O. Marsh reared adults from puparia of *Syrphus* sp. at Garden Grove, Calif., from *Allograpta fracta* and *Eupeodes volucris* at Brownsville, Tex. Mr. A. Willis reared adults from puparia of *Syrphus americanus* at Ottawa, Kan., and the writer has reared adults from puparia of *Baccha clavata*, *Mesogramma polita* and *Syrphus americanus* at Wellington, Kan. Messrs. Marsh and Smyth noted adults swarming about cabbage heavily infested with *Aphis brassicæ* at Brownsville, Tex.

On 14th of May, 1909, the writer, to his great surprise, observed the adult female of *Diplazon lætatorius* ovipositing in eggs of *Baccha clavata*. He never had supposed it possible that an Ichneumon would lay its egg in the egg of another insect, and especially in this instance, for the adult *Diplazon* measures 8 mm. in length, and the Syrphid egg not more than 1 mm. The *Diplazon* female crawls astride the Syrphid egg and thrusts her ovipositor in the egg in a similar manner to that of *Aphidius testaceipes* which is figured in U. S. Dept. Agri., Bu. Ent. Bul. 110, page 105. However, from these Syrphid eggs, young Syrphid larvæ issued and grew to maturity, feeding on *Aphis medicaginis*.

They pupated June 9 to 14, and, again to the observer's surprise adult *Diplazon lætatorius* issued June 24 to July 1, requiring about thirty-five days for development from egg to adult.

On May 24, 1912, the writer reared several adult *Diplazon lætatorius* of both sexes from puparia of *Syrphus americanus*. Two females from this lot were confined in a cage with a Black locust twig on which were ten Syrphid eggs among a lot of *Aphis medicaginis*. They sought out the Syrphid eggs at once and oviposited in each of them and in some of them the second time. The Syrphid eggs hatched May 26, and larvæ began feeding on aphids. They were nearly full grown on June 12 when it became necessary for the writer to be absent from the laboratory. On returning June 30, there were two *Mesogramma polita* and six *Diplazon lætatorius* in the cage. Mr. Irving Crawford, while working under the direction of the writer at Wellington, Kan., reared four *Diplazon lætatorius* from puparia of *Baccha clavata*. The *Baccha clavata* larvæ, of unknown age, were collected on September 13, 1912; seven of them pupated on September 15; two adult *Baccha clavata* issued on September 25 and four *Diplazon lætatorius* issued on October 9. These data indicate that *Diplazon lætatorius* requires about ten days longer to mature than its host.

Messrs. W. D. Pierce and T. E. Holloway have described a similarly complicated life-history of *Chelonus texanus*, JOURNAL ECONOMIC ENTOMOLOGY, Vol. 5, No. 6; stating in brief that *Chelonus* deposits her egg in the egg of the host, but the parasite emerges not from the egg but from the larva developed therefrom.

Messrs. T. H. Parks, W. R. McConnell and R. A. Vickery of this Bureau observed this peculiar habit of *Chelonus texanus* in the summer and fall of 1912, the former rearing the species through two generations in *Laphygma frugiperda*, each of which required but twenty-one days, the hosts in this case developing in twenty-four days.

Mr. Parks and the writer reared great numbers of this same parasite, from larvæ of *Loxostege similalis* in the vicinity of Wellington, Kan., in fall of 1909, during a severe outbreak of the latter species on alfalfa. The *Chelonus* then so completely overcame the *Loxostege* that by winter this pest was found only with great difficulty. In 1910, it was rarely found and in 1911, '12 and '13, it had not yet become abundant, which we have attributed to the effect of *Chelonus*.

Messrs. H. M. Russell and F. A. Johnston (JOURNAL ECONOMIC ENTOMOLOGY, Vol. 5, No. 6) relate a parallel case in the life-history of *Tetrastichus asparagi*. Given in brief, the adult *Tetrastichus* female oviposits in the egg of its host, the adults issuing from the mature larvæ. Doctor Marchal observed this same phenomenon in *Polygnotus minutus* in France with the added phenomenon of *Polyembryony*.

The writer observed *Polygnotus hiemalis* ovipositing in eggs of *Mayetiola destructor*, and reared adults of this parasite from the *Mayetiola destructor* puparium in the spring of 1908. Mr. Reeves of this Bureau is now engaged in a more exhaustive study of *Polygnotus hiemalis*.

It should also be stated in this connection that this same method of oviposition in the egg and the subsequent emergence of the adult parasite from the host larva occurs in *Ageniaspis* and *Litomastix*, with the added phenomenon of *Polyembryony*, as shown by Marchal and by Silvestri.

Thus there are now four families of *Hymenoptera*, in which certain forms have this method of parasitism; *Diplazon lætatorius* representing the *Ichneumonidæ; Polygnotus hiemalis* and *Polygnotus minutus* representing the *Proctotrypidæ; Chelonus texanus* representing the *Braconidæ*, and *Tetrastichus asparagi*, *Ageniaspis fuscicollis* and *Litomastix* (*Copidosoma*) *truncatellus* representing the *Chalcididæ*.

The writer first made these observations in spring of 1909, while working, alone, in Wellington, Kan., and could get no corroborative evidence, other than the reared specimens. The matter was presented to Dr. L. O. Howard for publication the following December, but owing to lack of corroboration, it did not at that time appear advisable to publish the data.

Scientific Notes

The Clover Leaf Weevil (*Hypera punctata*), common in the eastern states, has recently become abundant in a section of the Payette Valley in southwestern Idaho. A field of red clover was eaten to the ground and surrounding alfalfa seriously injured during April by the larvæ of this insect. The clover and some of the alfalfa were promptly plowed under to kill the larvæ.

The infested field of red clover is situated along the right of way of a branch line of the Oregon Short Line railroad which was constructed three years ago. Specimens of the insect can now be found in red clover and alfalfa fields extending for a distance of twelve miles up and down the valley, though little damage has yet been done except in two or three places.

There is no evidence of the presence of the fungus, *Empusa sphaerosperma* Fres, which so effectively controls outbreaks of this insect east of the Mississippi River, and some of this material, secured through the Section of Cereal and Forage Crop Insects of the Bureau of Entomology, has been recently introduced into the Payette Valley in an effort to establish it there.

This is the first instance of the occurrence of this insect in injurious numbers in the inter-mountain country and some anxiety is felt on account of the dry climate being unfavorable to the rapid spread of the fungus which controls the pest in the east.

T. H. Parks,
University of Idaho.

Economic Entomology Abroad. It is interesting to note that the example of the economic entomologists of the United States, in forming an Association of Economic Entomologists, is being followed by other countries. Dr. K. Escherich, after his visit to America in the summer of 1911, read a paper before the German Association of Zoölogists on "Economic Entomology in the United States." He followed this by the publication of his book with the same title in 1913, and in the summer of 1913, after preliminary correspondence, the first meeting of the German Association of Economic Entomologists was held at Würzburg under the presidency of Doctor Escherich. His address was on the general subject of economic entomology. Doctor Rübsamen read a paper on the eradication of the Phylloxera in Prussia. Doctor Heymons, of Berlin, spoke concerning the entomological institutions of Italy and of the work accomplished in that country in economic entomology. Dr. L. Reh, of Hamburg, discussed entomological conditions in Germany. Doctor Aulman spoke of economic entomology in the German colonies. Fostrath Orth described the anti-Phylloxera work in Germany. Doctor Bolle of Goritzia, Austria, gave an illustrated lecture on the work of insects in libraries and also read a paper on the good work of *Prospaltella berlesei* versus *Aulacaspis pentagona* in South Austria. Doctor Zandler, of Erlangen, read a report on apiculture. Doctor Teichman, of Frankfort, discussed the tsetse fly. Doctor Schulze, of Berlin, spoke of the wild silkworms of South Africa and their practical use. Doctor Börner gave the bionomics of *Phylloxera pervastatrix.* Forstassessor Hænel read a paper on the protection of birds and of the service of birds in the fight against injurious insects. Doctor Prell, of Tübingen, presented a paper on Tachinid flies. Doctor Jablonowski, of Budapest, spoke of *Tapinostola musculosa* and its damage to wheat.

Much was said about the good work of the American Association of Economic Entomologists, and Dr. L. O. Howard was elected the first honorary member of the newly founded association.

Contemporaneously, an Association of Economic Entomologists of Russia has been founded, and its first meeting was held at Kieff last autumn. This was the organization meeting, and the next meeting is called for October, 1914, also in Kieff. The details of the organization meeting and of the officers elected have not yet been received.

The Canadian Entomological Service. Thirty years ago, in 1884, the Canadian Government appointed a dominion entomologist to advise agriculturists and others regarding the control of insect pests. Two years later, on the establishment of the Experimental Farms system, Dr. James Fletcher, who occupied the position, was attached to the new branch of the Department of Agriculture in the joint capacity of entomologist and botanist, which position he occupied with conspicuous success until his death in 1908. The growth in importance of the subjects necessitated their separation and accordingly Divisions of Entomology and Botany were created. Dr. C. Gordon Hewitt was appointed dominion entomologist in 1909 and entrusted with the work of organizing the new Division of Entomology of the Experimental Farms Branch of the Department of Agriculture with offices and laboratory at the Central Experimental Farm, Ottawa.

The urgent need of legislation, in order to permit action to be taken to prevent the introduction into Canada and spread within the country of serious insect pests and plant diseases, was responsible for the passage of the Destructive Insect and Pest Act in 1910. The still greater need of investigations on the insect pests affecting agriculture, forestry and other branches of human activity has led to the establishment of field or regional laboratories in different parts of Canada with trained entomologists in charge to study local problems.

Owing to the consequent expansion of the entomological work along investigatory and administrative lines and the fact that such work did not constitute a necessary part of the work of the Experimental Farms system and executively was virtually distinct, the Entomological Service has now been separated from the Experimental Farms Branch and has been constituted an independent Branch of the Department of Agriculture under the direction of the dominion entomologist. It is proposed to erect a building to provide offices and laboratories for the new Entomological Branch. Will correspondents kindly note that all official communications and publications should be addressed to "The Dominion Entomologist, Department of Agriculture, Ottawa."

This reorganization, which will also include the establishment of a national collection of the insects of Canada in the Canadian National Museum (the Victoria Memorial Museum) at Ottawa under the care of the dominion entomologist, marks an important step in Canadian entomology. It will result in a still greater development of the study of Canadian insects along scientific and practical lines.

An Unusual Occurrence of Walking-sticks. During the past summer (1913) the woods in the vicinity of Peterson, Iowa, showed walking sticks, *Diapheromera femorata*, in numbers which constituted a veritable pest. The woods are principally oak, with smaller numbers of elm, ash, aspen, linden, hickory and black walnut trees and a heavy undergrowth of hazel. On the 30th of May it was observed that the hazel bushes were quite covered with recently hatched walking-sticks, varying from three or four millimetres to a centimetre in length, in color they were a very pale yellowish green.

By the first of August they had begun to leave the timber and appear in the orchard and around the house. In the orchard they infested particularly one tree of early apples, devouring nearly all the leaves; on a single twig six inches in length I counted sixteen clustered together and they were equally numerous over the entire tree.

The woods had become forbidden ground to us; if one were sufficiently brave to start through them, the walking-sticks fell to the ground from every tree in such numbers as to sound like hail. Through August and September there were seldom fewer than fifty on our screen door each morning. The little chickens were particularly enthusiastic over them and soon learned to appear when we swept them off the doors in the morning. In spite of the long awkward bodies and clinging legs of the insects, they were soon able to devour them quickly and deftly.

By mid-September the timber showed stretches a couple of hundred feet broad and half a mile long where the trees had been completely defoliated. The walking sticks began to cross the road to another piece of timber in which there had been almost none of the insects and every passing carriage or motor crushed them by hundreds. This extremely local character of the infestation was a curious feature. One piece of timber containing about two hundred acres was almost wholly stripped, while a similar piece across the road was scarcely touched. It would appear that no walking-sticks matured there, and the slight damage done was by migrants from the other timber. There was an apparent disparity in numbers between the males and the females, though the apparent scarcity of females may be due to their greater sluggishness. During the latter part of the season the females appeared in slightly greater numbers.

HORTENSE BUTLER.
State College, N. M.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

JUNE, 1914

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

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This issue completes the proceedings of the Atlanta meeting except the papers read by title. The latter will appear in the August number. Other papers will be published as rapidly as space limitations permit.

There is a solidarity among editors, doubtless due to a similarity in their problems and perplexities, and we find much of truth in an editorial indited by a brother in Philadelphia and appearing in the April number of ENTOMOLOGICAL NEWS. We commend the paragraph to the attention of our readers and take this opportunity to express the hope that future contributors to this JOURNAL will bear in mind the principles firmly but gently stated by our contemporary. A little regard for the rights and privileges of others helps amazingly in avoiding unnecessary friction.

The advance in medical entomology and the economic importance of the Diptera are well shown in this issue. The articles on the house fly and its control and the discussion of the magnificent work against mosquitoes in New Jersey are not only timely but should be referred to by every entomologist who would keep posted along these lines. We are only at the beginning of a comparatively unknown and unworked field fraught with great potentialities. There is much yet to be done in working out the life-histories of economic species and particularly in learning those practical details essential to efficient control. Much of this work should be done in close coöperation with the medical investigator in order to secure the best results with the least loss of effort. It is a pleasure to note that two important works on disease-carrying insects have recently been published. These, to be reviewed shortly, give a comprehensive idea of their respective fields and will prove of great service to those engaged in similar lines of work.

Current Notes

Conducted by the Associate Editor

Dr. Paul S. Welch, instructor in entomology, Kansas State Agricultural College, has been advanced in rank to assistant professor.

Mr. A. C. Morgan, of the Bureau of Entomology, returned to his field station at Clarksville, Tenn., on March 25.

Professor O. H. Johannsen has been promoted to a full professorship in entomology in Cornell University.

Mr. Joseph S. Obecny has been appointed field assistant in entomology, at the Agricultural Experiment Station, New Brunswick, N. J.

U. C. Loftin of the Bureau of Entomology, has returned to New Orleans after several months spent in Brownsville, Texas, in the study of sugar cane insects.

At the meeting of the American Philosophical Society at Philadelphia, April 25' Mr. Alfred Goldsborough Mayer, of Washington, D. C., was elected a member.

Professor P. J. Parrott, Entomologist of the Experiment Station, Geneva, N. Y., has just commenced work again, having fully recovered from a serious illness of several weeks.

Dr. W. D. Hunter, of the Bureau of Entomology, left on March 23, for a short trip of inspection of the Rocky Mountain spotted-fever tick work in the Bitter Root Valley of Montana.

Mr. W. B. Wood, of the Bureau of Entomology, has returned to Washington after a stay of several weeks in California, where he was assisting in the work for the control of the pear thrips.

Mr. A. H. Jennings, of the Bureau of Entomology, will resume his work on pellagra at Spartanburg, S. C., in connection with the Thompson-McFadden Pellagra Commission, about May 1.

Mr. William H. White, B.S., Maryland Agricultural College, has been appointed Scientific Assistant, Bureau of Entomology, and assigned to work on truck-crop insects in Maryland.

Messrs. G. A. Root and J. E. Hutson, graduate students at the Massachusetts Agricultural College, are serving temporarily as nursery inspectors for the State Board of Agriculture.

Mr. S. Mokshetsky has been appointed director of the Pomological Experiment Station, which has been recently established in the town of Simferopol, Crimea, Russia.

Dr. L. O. Howard has been elected an honorary member of the new German Association of Economic Entomologists, which held its first meeting at Madgeburg October, 1913.

Mr. H. H. Lyman and his wife, of Montreal, we are informed, were passengers on the ill-fated *Empress of Ireland* and it is feared that they were among the lost.

Mr. M. P. Zappe, a graduate of the Connecticut Agricultural College, will be employed during the summer as assistant in the entomological department of the Agricultural Experiment Station at New Haven.

Mr. Thomas H. Jones, Collaborator of the Bureau of Entomology, stationed at Rio Piedras, Porto Rico, has been visiting Washington for study and perusal of literature, and the identification of specimens.

Mr. L. S. McLaine, who has charge of the brown-tail moth work in the Province of New Brunswick, Canada, will be stationed at the Parasite Laboratory, Melrose Highlands, Mass., for the next four months.

Mr. Don Whelan, a graduate student of the Kansas State Agricultural College, has received a fellowship in the Graduate School of Ohio University, where he will continue his work in entomology.

The allowance made to the Department of Entomology, Ohio Agricultural Experiment Station, for all purposes, salaries and running expenses from February 16, 1914, to February 15, 1915, is $11,633.07.

Mr. Herman H. Brehme has resigned as mosquito drainage inspector, Agricultural Experiment Station, New Brunswick, N. J., and is now manager of the New Jersey Entomological Company of Newark, N. J.

Messrs. H. G. Ingerson and H. K. Plank, graduates of the Pennsylvania State College, have been appointed as scientific assistants in the Bureau of Entomology, their work beginning April 18, 1914.

Mr. B. R. Coad, of the Bureau of Entomology, left Washington on April 1, for Arizona, where he will remain during the season to study the relations between *Thurberia* insects and cotton culture. His address will be Tucson, Ariz.

Mr. C. C. Hamilton, a graduate student assistant of the Department of Entomology, Kansas State Agricultural College, has received a fellowship in the Graduate School of the University of Illinois, where he will continue his work in entomology.

Mr. Ralph R. Parker, 1912, Massachusetts Agricultural College, and a graduate student there, has accepted for the summer, an appointment in Montana to investigate conditions in connection with the house fly and its relation to the spread of diseases.

Mr. G. N. Wolcott, of the Porto Rican Board of Agriculture, visited Washington, D. C., March 27. He will spend the spring months in Illinois collecting *Lachnosterna* parasites for introduction into Porto Rico. He will spend the summer in Europe on leave.

Messrs. Arthur J. Ackerman and Daniel G. Tower have finished their work for the degree of Master of Science at the Massachusetts Agricultural College, and are now engaged in inspecting nursery stock for the State Board of Agriculture, with headquarters at Boston.

Mr. J. L. King, who has been completing his course at the Ohio State University, receives his Bachelor's degree in June and will resume work with the Ohio Station in late June, going to his laboratory at Gypsum.

Mr. R. H. Hutchinson, of the Bureau of Entomology, left on March 22 for New Orleans, where he will conduct further investigations of the treatment of manure piles in the control of the house fly, in coöperation with the Bureaus of Chemistry and Plant Industry.

Mr. William P. Hayes, a graduate of the Kansas State Agricultural College, has been appointed assistant in entomology at the Kansas Agricultural Experiment Station, and is now stationed in the southern part of the state on the state crop insect investigations.

Mr. Fred A. Johnston, entomological assistant in the Bureau of Entomology, who has been in Washington, D. C., for consultation and bibliographical and scientific work, has returned to Riverhead, Long Island, where he is engaged in investigation of insects affecting potatoes, cauliflower, asparagus, and other truck crops.

Mr. E. H. Siegler, of the Bureau of Entomology, has left California, where he was assisting in the work for the control of the pear thrips, returning to the station at Benton Harbor, Mich., for the purpose of carrying on experiments with insecticides against orchard insects.

Mr. John E. Graf, Scientific Assistant, Bureau of Entomology, who has been in Washington during portions of January, February and March for consultation and study, has returned to his permanent quarters at Whittier, Calif., to resume work on the sugar-beet wireworm, potato-tuber moth and other insects affecting vegetable and truck crops.

Mr. H. O. Marsh, Scientific Assistant, Bureau of Entomology, after an absence of a few months, during which he took a special course at the Kansas Agricultural College, Manhattan, Kansas, has returned to his headquarters at Rocky Ford, Colo., where he will continue investigations on insects affecting sugar beets and truck crops.

Mr. R. S. Woglum, of the Bureau of Entomology, has returned to Whittier, Calif., to continue his work with hydrocyanic-acid gas and the special citrus insects of that region. Mr. Arthur D. Borden, a graduate of Leland Stanford Junior University, and highly recommended by Professor Kellogg, has been employed and assigned to Mr. Woglum as a field assistant.

Mr. J. N. Summers, who has been conducting parasite investigations at the Gypsy Moth Laboratory for the past three years, will sail for Europe in April and will make observations on the fluctuations in increase of the gypsy moth in German forests, and collect and ship parasites to the Gypsy Moth Laboratory for colonization in this country.

Mr Alfred E. Cameron, Government Scholar of the Board of Agriculture, England, has recently arrived in the United States from the Department of Agricultural Entomology of the Victoria University of Manchester. Mr. Cameron is to spend the summer and autumn working under Dr. T. J. Headlee at the Entomological Department of the New Jersey Agricultural Experiment Station, New Brunswick, N. J.

A laboratory has been established in Winchester, Va., by the Bureau of Entomology, for conducting studies in the life-history and methods of control of the peach tree borer and orchard plant-lice. Mr. E. B. Blakeslee will be in charge of the work, assisted by Mr. B. R. Leach. Mr. Leach will give especial attention to remedies to be employed in the control of the woolly apple aphis.

Mr. S. S. Crossman, who was formerly engaged as an assistant on the citrus fruit insect investigations in Florida, and has during the past two years been employed in Porto Rico investigating economic insects, as an assistant to the entomologist of the Board of Agriculture, Porto Rico, has been appointed as scientific assistant of the Bureau of Entomology, and will carry on investigations on parasites at the Gypsy Moth Laboratory.

According to the *Experiment Station Record* at the University of Manchester, Eng., "the new laboratory for research work in agricultural entomology was opened November 13, 1913, by Sir Sidney Oliver, permanent secretary of the Board of Agriculture and Fisheries. A laboratory room fifty-eight by twenty-eight feet is available, together with a smaller laboratory, an experimental field with greenhouses, etc. Dr. A. D. Imms, formerly forest entomologist of the government of India, has been appointed first reader in agricultural entomology and will conduct researches and supervise the work of research students."

Mr. James W. Chapman, who was granted a Doctor's degree by the Bussey Institution of Harvard University, and who for the past two years has been engaged as entomologist to the Park Department of the City of Boston, has been appointed as Scientific Assistant of the Bureau of Entomology and will take up experimental work with Mr. R. W. Glaser of that Bureau on the "wilt" disease affecting the gypsy moth. Mr. Chapman published some time ago a bulletin on the leopard moth, *Zeuzera pyrina*, and several other insect enemies of shade trees.

According to *Science* (issue of May 15) Prof. W. C. O'Kane, professor of economic entomology at the New Hampshire College, and Entomologist of the Station, has been elected professor of zoölogy and entomology at the Ohio State University, Columbus, Ohio, from which he graduated in the class of 1907. Professor O'Kane was appointed to his position in New Hampshire on the resignation of Prof. E. D. Sanderson in 1910, and was recently appointed deputy commissioner of agriculture, in charge of the gypsy and brown-tail moth work of that state.

An exhaustive report on the destruction of the immature stages of the house fly in stable manure is about to be published. This is the result of coöperative work with the Bureau of Chemistry and Plant Industry in which particular attention was paid to the effects of various applications on the fertilizing value of the manure. This report will be published as a contribution from the Bureau of Entomology. (From *News Letter No. 2, Bureau of Entomology.*)

Since the promulgation of the quarantine against foreign cotton seed on account of the danger of introduction of *Gelechia gossypiella* and other pests, it has been found that a small amount of esed comes to this country in baled cotton lint from Egypt. J. L. Webb investigated this matter in New Bedford and Fall River, Massachusetts. It was found that the amount of seed brought in in the way described is small, but one live pink boll worm was discovered. The danger from this source is clear from the fact that considerable quantities of Egyptian cotton are shipped to the southern mills which, in many cases, are adjacent to cotton fields. (From *News Letter No. 2, Bureau of Entomology.*)

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(Continued)

(Papers read by title.)

SOIL FUMIGATION

By J. A. Hyslop, *Bureau of Entomology, U. S. Department of Agriculture*

Subterranean insects have always been the source of more or less embarrassment to the entomologist engaged in field crop insect investigations. In greenhouse management and truck crop growing very efficient treatments have been devised, as the intensive methods in these branches of agriculture make possible and profitable methods that, in field crop farming, are prohibited by cost and labor. Among field crop pests, forms which complete their life cycles within one year and which transform more or less uniformly and contemporaneously, have been quite successfully combated by cultural methods. These same methods are also being generally recommended for such forms as wireworms (*Elaterid* larvæ) and white grubs (*Lachnosterna* larvæ) which spend more than one season in the soil as larvæ. These methods, even though carried out most thoroughly, cannot, from the nature of the life histories of these pests, be efficient in less than two years and in the case of forms like *Melanotus* spp. in which the larval stage extends over three winters, three years of combative culture will be required to rid a field of the pest. It is with this knowledge that such recommendations are made, not because they are believed to be efficient but because no better treatment has, as yet, been brought forward.

In the following paragraphs will be outlined a radical departure

from the general line of remedial work against subterranean insects. This departure is soil fumigation and, inasmuch as we have only tried one fumigant, soil fumigation with sodium cyanide.

Three phases of any remedial measure always confront the investigator; first, will the remedy in question be efficient; second, will it be practicable and safe; and third, will it be economical. The work of the past season, which will be reviewed in detail later and which was carried on under the Office of Cereal and Forage Crop Insect Investigations of the National Bureau, proved the first of these phases affirmatively. The practicability of the treatment resolves itself into two questions, how shall we apply the fumigant, and when shall we apply it. The first question is being investigated by consultation with commercial chemists and manufacturers of farm machinery. The second question was partly solved by pot and field experiments this season. Four possible and practicable times of application present themselves; first, with the fertilizer at the time of seeding; second, drilling in with an attachment at the time of corn cultivation; third, at the time of fall ploughing; and fourth, at the time of spring ploughing.

The great danger attached to the use of cyanide on the farm, both to men and live stock, is, perhaps, the most serious negative factor that the initial work has faced and may ultimately render the treatment inadvisable.

Another serious factor in determining the final value of this remedial measure is its ultimate effect upon the microbiota of the soil. Recent botanical investigations have proved the interdependence of certain plants, notably the *Leguminosæ*, and certain bacteria. Investigators have also found other free living nitrifying bacteria in the soil and now believe that the fertility of the soil is largely dependent upon the activities of microörganisms. If the cyanide destroys these beneficial and necessary bacteria, reinoculation will be necessary after the cyanide treatment. However, that this absolute soil sterilization would be undesirable, is not as evident as it might seem on casual consideration. From the statements of Russel and Hutchinson of the Rothamstead Experiment Station (England) quoted by Prof. T. B. Wood in his presidential address before the Agricultural Section of the British Association for the Advancement of Science at Birmingham this year, the so-called soil toxicity, held to be caused by toxic substances produced by the crops themselves, is in reality not a soil toxicity but a soil impoverishment. The soil is depleted of its nitrifying bacteria by certain protozoa which feed upon these bacteria. These undesirable protozoa would be killed as well as their prey and reinoculation would be more than compensated by the vigorous development of the newly introduced bacteria in the absence of their depredators.

Mr. L. D. Larsen of the Hawaiian Sugar Planters' Experiment Station has found that protozoa are very abundant in Hawaiian soils and that soil fumigation with carbon bisulphid acted as a decided stimulus to crop production.

In the experiments so far carried on, the treatment has been so costly as to be prohibitive in actual farm practice. However, this is not to be regarded as a serious factor, for cyanide can undoubtedly be produced in a much cheaper form than that used in the trials, and smaller dosage with cheap filler will very probably make the treatment economically available.

The laboratory work was all carried on at the United States Field Laboratory located at Hagerstown, Md., and in this work Mr. C. M. Packard assisted materially. The field work was carried on at Wolfville, Md., near Hagerstown, and at Bridgeport, N. Y., near Syracuse.

The laboratory work was started late in May by a series of pot experiments to determine the effect of the fumigant upon the crop to be treated. Corn was selected as the crop because it is probably more generally and seriously damaged by subterranean insects than any of the cereal and forage crops. The cyanide used in these experiments was not the c. p. sodium cyanide but a commercial mixture containing from 39 per cent to 40 per cent of cyanogen, the equivalent of 98 per cent to 99 per cent potassium cyanide. The mixture was as follows:

Sodium cyanide........................	74 per cent to 76 per cent
Alkaline chlorides........................	16 per cent to 24 per cent
Inert substances........................	2 per cent to 8 per cent

The pots used in all the laboratory work were unglazed earthenware flower pots six inches in diameter and six inches in depth. This size pot was selected because the general depth of ploughing is about six inches and by simply determining what fractional part of an acre was contained in the exposed surface of earth in a pot, the dosage could be roughly determined in terms of pounds per acre. The earth used in these experiments was ordinary corn field earth from a neighboring farm and the entire batch was thoroughly mixed to eliminate as far as possible all variables but those intentionally introduced. Three series were used, each series containing twelve pots divided into four groups of three pots each. In the first series (Division A) all the pots were seeded and treated on the same day, May 29. In the first group of three pots in this series no cyanide was used and the group served as a check. The second group contained one scruple of cyanide to the pot, roughly 300 pounds to the acre; the third, one dram, 900 pounds to the acre; and the fourth, two drams, 1700 pounds to the acre. In the second series of twelve pots (Division B) the cyanide dosage and

check were as in the first series but no seed was planted on the date of soil treatment. The treatment with cyanide in this series was on May 29. On June 10 one pot from each of the four groups in the series was seeded. On June 24 a second pot from each group was seeded and on July 8 the remaining pot in each group was seeded. The third series of twelve pots (Division C) was entirely seeded on May 29 but no cyanide treatment was made at the time of seeding. The first group of three pots was never treated with cyanide and, as in series *A* and *B*, served as a check. The second group was treated with cyanide, June 10, the same amounts being used as in the other series. The third group was similarly treated on June 24 and the fourth group was similarly treated on July 8. The accompanying tables are self-explanatory. The experiments showed conclusively that sodium cyanide cannot be placed in the soil at the time of seeding with the fertilizer and cannot be placed in the soil during the process of cultivation subsequent to seeding. These experiments also show that sodium cyanide is decreasingly poisonous up to from twenty-six to forty days after application, after which no appreciable difference can be found between treated pots and untreated checks, thus setting a margin of danger in seeding, after treatment with this fumigant, of forty days.

As laboratory results are always subject to discrepancies, due to necessarily artificial conditions, two field experiments were conducted at Wolfville, Md., and a third at Bridgeport, N. Y. The two field experiments, at Wolfville, Md., were conducted during the month of June. In one field cyanide, at the rate of about 300 pounds per acre, was drilled into the corn hills by hand, simulating, as near as possible, the depth and distance from the plants that it would be if drilled in by machinery when cultivating the crop. The corn in this field was planted on May 13 and the plants were about ten inches tall when treated on June 6. Sixty-seven hills were treated. The field was again visited on June 18 and on that date every treated hill was killed out, the plants being dried up. In another field cyanide was applied at the rate of about 150 pounds per acre in the same manner as the above and when again examined on June 18 gave the same results.

The field experiments at Bridgeport, N. Y., come under two headings, to answer the first and third phases of remedial measures as outlined in the third paragraph of this paper. Wireworms (*Agriotes mancus*) were in the fields in enormous numbers, in fact so numerous that application was made to our office for assistance. Corn was so badly infested that some fields were reseeded while all were "planted in" as a result of the depredations of these insects. The general practice on the farms in this region, which are principally hay farms, is to keep land in sod for three years at least and, if it is still producing a fair

quality of timothy hay, to continue the sod for from five to seven years. The conditions are, therefore, ideal for experimentation of the nature under discussion. The farm on which we are working is level and remarkably uniform in the matters of soil and drainage, the latter, due to the contour, being artificial surface drainage by the method known as "land ploughing," that is, leaving a dead furrow every fifteen or twenty feet which drains into deep permanent ditches.

The wireworms were attacking several crops other than corn, among which might be mentioned potatoes, beans, carrots, wheat and mushrooms. Potatoes were riddled by these insects, as many as ten larvæ being found in a single tuber. As the worms were concentrated in the potato hills these were the first to be treated to determine the first and principal phase of the problem, namely, the efficiency, regardless of all other factors, of the remedy in question.

On October 1 cyanide was placed in fifteen hills by hand at the rate of 300 pounds per acre, the treated hills being consecutive in the row and with untreated hills on either side of the treated area. On October 4 three of the treated hills were dug out and examined. The larvæ were still numerous but inactive. They were in a very abnormal attitude, being distended and straight, presenting a rigid corpse-like appearance. Fifty of these larvæ were collected and placed in small tin boxes with moist sphagnum moss to determine whether they were actually dead or merely temporarily overcome by the cyanide. In several adjoining untreated hills all the larvæ were active and normally distended. Fifty of these larvæ from untreated hills were placed in boxes similar to the treated hill specimens as a check. At the end of three days the two groups of boxes were examined. The larvæ from treated hills were all dead and had started to discolor while the check specimens were alive and active. On October 9 the remaining treated hills were dug out, no living insects of any kind were to be found in the hills above the depth to which the cyanide had been introduced, *i. e.*, six inches. Many dead larvæ were still to be found, while in all the remaining hills of the patch, examined when the crop was dug, living active larvæ were still feeding on the tubers. Thus was the first phase of the remedy conclusively proved in the affirmative. *Sodium Cyanide will kill wireworms if correctly applied.*

The second experiment has not yet been concluded. It is being carried on in a 20-acre field which has been in sod since 1910. This field immediately adjoins the potato field in which the above experiments were carried on. A strip containing one twentieth of an acre, bounded on the east by the potato field before mentioned, on the west by a piece of fall plough sod similar to itself and on the north by a continuation of the same ploughing, has been treated by sowing, by

hand, finely crushed sodium cyanide at the rate of 500 pounds per acre. The pieces were approximately as large as a pea. This heavy dosage was applied in order to give striking and easily recognizable results. The cyanide was sown in the furrows and the sod turned on top of the poison. The ploughing was quite evenly seven inches and thus the poison was quite uniformly buried to this depth. All of this field will be planted to corn next spring. A strip, of about one-half-acre area, was left in the field for spring ploughing and an area on this will be treated with cyanide at the time of ploughing. Across the field, at right angles to the ploughing and also the cyanide experiment, a strip is to be treated with lime at the rate of one ton to the acre. This strip will cross part of the cyanide treated area. The above experimental plat was arranged to throw light on the following questions; will sodium cyanide affect the soil chemically or physically, if so, will the effect be influenced by the time of treatment and time of ploughing; and will the cyanide be affected in its relation to the soil or in its relation to the insects by liming. Aside from the subject under discussion the older remedial measure of culture will receive additional data.

The pertinent results of this season's work may be summarized as follows; first, sodium cyanide will not permanently injure the soil; second, it cannot be applied while the crops are on the land nor immediately prior to seeding, and third, it will kill wireworms.

LABORATORY EXPERIMENT WITH SODIUM CYANIDE—DIVISION *A*

Division	Pot Number	Insecticide Treatment		May 29	June 10	June 15	June 24	July 8	July 15	July 26
		Amount	Date							
A	1	None....	May 29..	Seeded...	4 sprouts.	5 plants..	5 plants..	Discontinued this check.		
	2	None....	May 29..	Seeded...	3 sprouts.	6 plants..	6 plants..			
	3	None....	May 29..	Seeded...	2 sprouts.	2 plants..	2 plants..			
	4	1 scr.....	May 29..	Seeded...	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted
	5	1 scr.....	May 29..	Seeded...	"	"	"	"	"	"
	6	1 scr.....	May 29..	Seeded...	"	"	"	"	"	"
	7	1 dram ..	May 29..	Seeded...	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted
	8	1 dram ..	May 29..	Seeded...	"	"	"	"	"	"
	9	1 dram ..	May 29..	Seeded...	"	"	"	"	"	"
	10	2 drams..	May 29..	Seeded...	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted	No seed sprouted
	11	2 drams..	May 29..	Seeded...	"	"	"	"	"	"
	12	2 drams..	May 29..	Seeded...	"	"	"	"	"	"

CONDENSED RESULTS OF DIVISION *A* OF POT EXPERIMENTS

Pot Number	Treatment	Percentage of Living Plants at End of Experiment
1-2-3	Check	72%
4-5-6	1 scr.	0%
7-8-9	1 dram	0%
9-10-11	2 drams	0%

LABORATORY EXPERIMENT WITH SODIUM CYANIDE—DIVISION *B*

Division	Pot Number	Insecticide Treatment		May 29	June 10	June 15	June 24	July 8	July 15	July 26
		Amount	Date							
B	1	None	May 29		Seeded	1 sprout	1 plant	1 plant	1 plant	1 plant.
	2	None	May 29				Seeded	5 plants	5 plants	5 plants.
	3	None	May 29					Seeded	5 plants	5 plants.
	4	1 scr.	May 29		Seeded	1 sprout	1 plant	1 plant	1 plant	1 plant.
	5	1 scr.	May 29				Seeded	1 plant	1 plant	1 plant.
	6	1 scr.	May 29					Seeded	5 plants	5 plants.
	7	1 dram	May 29		Seeded		1 plant	Died	No plant.	No plant.
	8	1 dram	May 29				Seeded	3 plants	3 plants	3 plants.
	9	1 dram	May 29					Seeded	6 plants	6 plants.
	10	2 drams	May 29		Seeded		No plant.	No plant.	No plant.	No plant.
	11	2 drams	May 29				Seeded	2 plants	2 plants	2 plants.
	12	2 drams	May 29					Seeded	4 plants	4 plants.

CONDENSED RESULTS OF DIVISION *B* OF POT EXPERIMENTS

Pot Number	Seeded	Percentage of Living Plants at End of Experiment
1-2-3	Check	61%
4-7-10	12 days after treatment	5%
5-8-11	26 days after treatment	33%
6-9-12	40 days after treatment	83%

LABORATORY EXPERIMENT WITH SODIUM CYANIDE—DIVISION C

Division	Pot Number	Insecticide Treatment		May 29	June 10	June 15	June 24	July 8	July 15	July 26
		Amount	Date							
C	1	None....	....	Seeded...	5 plants..	5 plants..	5 plants..	5 plants..	5 plants..	5 plants.
	2	None....	....	Seeded ..	6 plants..	6 plants..	6 plants..	6 plants..	6 plants..	....
	3	None....	....	Seeded...	6 plants..	5 plants..	5 plants..	5 plants..	5 plants..	5 plants.
	4	1 scr.....	June 10..	Seeded...	4 plants[1]	....	All dead .	....	....	....
	5	1 dram ..	June 10..	Seeded...	6 plants[1]	....	All dead .	....	....	....
	6	2 drams..	June 10..	Seeded...	5 plants[1]	....	All dead .	....	....	....
	7	1 scr.....	June 24..	Seeded ..	6 plants..	6 plants..	5 plants[1]	....	All dead .	....
	8	1 dram ..	June 24..	Seeded...	2 plants..	2 plants..	2 plants[1]	....	All dead .	....
	9	2 drams..	June 24..	Seeded...	6 plants..	6 plants..	6 plants[1]	....	All dead .	....
	10	1 scr.....	July 8 ...	Seeded...	6 plants..	6 plants..	6 plants..	6 plants[1]	....	All dead.
	11	1 dram ..	July 8 ...	Seeded...	6 plants..	6 plants..	6 plants..	6 plants[1]	....	All dead.
	12	2 drams..	July 8 ...	Seeded...	5 plants..	5 plants..	5 plants..	5 plants[1]	....	All dead.

[1] Indicates date on which cyanide was applied.

CONDENSED RESULTS OF DIVISION C OF POT EXPERIMENTS

Pot Number	Treated with Cyanide	Percentage of Living Plants at End of Experiment
1-2-3....................	Check..................	88%
4-5-6....................	12 days after seeding	0%
7-8-9....................	26 days after seeding	0%
10-11-12................	40 days after seeding.....	0%

Colonel William C. Gorgas, Surgeon-General of the United States Army, received the honorary degree of Doctor of Science from Princeton on June 16, and of Doctor of Laws from Yale University on June 17. In presenting him for this honor at Yale, Professor Cross spoke as follows:

"William Crawford Gorgas, Surgeon-General of the United States Army. It is needless to rehearse the career of General Gorgas. As chief sanitary officer of Havana, he entered into a close fight with yellow fever and drove that disease from the Cuban capital. As medical director of the Panama Zone, his application of the lessons of science to practical hygiene and sanitation made possible the completion of an immense engineering project. In recognition of his splendid achievement, he has been honored at home and abroad by degrees, medals, and membership in scientific societies—and most impressively by his recent call to South Africa to improve the sanitary conditions in the mining district of the great Wit watersrand. To General Gorgas, as to few others, has been allotted the extreme distinction of having the story of his achievements become a part of current history and to command the admiration of the civilized world. Of old, this honor came to conquerors who left blood and slaughter in their trail; it has come to General Gorgas for the unnumbered lives he has saved."

SOME FACTORS AFFECTING RESULTS IN THE USE OF HIGH TEMPERATURE FOR THE CONTROL OF INSECTS INJURING CEREAL PRODUCTS

By W. H. Goodwin

In some experiments in treating flour mills using heat, several failures were experienced when apparently sufficient radiation had been installed. These mills had proportionally as much radiation as similarly constructed mills in which excellent results had been obtained. A careful survey of these mills failed to disclose any lack of steam pressure; neither was the failure due to only partial circulation of steam in the radiator coils; nor to a greatly reduced opening in the steam pipes leading to the heating coils. In one or two mills a lack of steam pressure owing to the small or greatly reduced passage ways of the steam mains, or feed pipes, was readily discovered and the trouble soon remedied. In two flour mills, however, leaks in the heating coils produced an extremely moist atmosphere, and although the temperature was high enough to kill most of the stages of the Mediterranean flour moth, especially the small larvæ, many of the other minor mill pests survived and appeared to be none the worse for having been heated. The temperatures attained, 45°C. to almost 47°C., were high enough to kill many of the insects present, but, apparently, on account of the relatively high humidity many survived. These insects which survived the test were not greatly disturbed, even when the duration of the heating period was greatly lengthened. The heated atmosphere did not seem to penetrate very deeply into any collections of flour which occurred in machines or in conveyors in which these insects lived. The treated insects which survived acted perfectly normal after the test, and reproduced normally later in the year. This appeared to disprove the practical efficiency of high temperature for the control of cereal insects, unless a greatly increased amount of radiation was provided.

The amount of radiation present, already exceeded the requirement for similarly constructed flour mills, in which excellent results had been obtained. The only factor which appeared to be responsible for the extreme difference and that was preventing the necessary rise in temperature above 45°C. to the fatal temperature for most insects, 48°C. to 52°C., was the extreme humidity of the heated atmosphere. The thermal conductivity of the wood floors being very small, the evaporation was not rapid, but the amount of heat absorbed by the evaporating water cooled the atmosphere in the mill being treated to such an extent that the necessary rise in temperature above 45°C. to the fatal

temperature, 48°C. to 52°C., could not be attained. This temperature kills all stages of the cereal pests that I have tried in laboratory experiments, excepting the young larva of *Trogoderma ornatum*, which often requires 53°C. to 54°C. before succumbing to the effects of heat.

In one flour mill all the return pipes from the heating system emptied into open condensing tanks in the basement of the mill. The heating of this mill was a partial failure, apparently due to the humid atmosphere and also to not being properly equipped with steam traps, or condensers, so that a steam pressure of 40 to 60 pounds could be used in the entire heating system.

Soon after these failures to obtain the fatal temperature, experiments were begun to substantiate or disprove this relative humidity theory. A small water-jacketed oven was pressed into service; several small hygrometers, some of which later proved to be inaccurate, and a gas burner and some accurate thermometers completed the first set of apparatus. A large series of tests using this oven, placing therein the insects and material treated in small glass vessels with brass-cloth lids to confine the insects, gave results which seemed to substantiate the humidity theory. These results were not technically exact, hence they need no further comment, excepting the fact, that they proved that moisture is a very important factor when using high temperatures for the control of the insects affecting cereals and cereal products.

The amount of heat required for a dry-atmosphere, high-temperature test was much less than for an extremely moist-atmosphere test, demonstrating the necessity for more careful and exact experiments along these lines, and proving in a rough way that the leaks in the heating system and wet floors were responsible for the partial failures mentioned.

Later, a small water-jacketed oven with an air-space surrounding the water-jacket was procured and better grade hygrometers, besides the wet and dry bulb thermometers, and an apparatus was devised for circulating the air in the oven around the wet bulb thermometer. Brass wire-cloth containers for the insects and material were also constructed in order to get more exact and uniform conditions throughout the oven, and in the material treated. These small wire-cloth containers permitted the passage of the air through their walls and also the rapid escape and ingress of moisture. It permitted the humid air in the moist-atmosphere tests to come in direct contact with the insects being treated, allowing very small chance for error. A series of experiments were made, taking into consideration the previous experiments and avoiding, as far as possible, the discrepancies which occurred in the first series of tests.

The inner walls of the incubator oven were covered with blotting

paper saturated with water, thus completely preventing condensation when making moist-atmosphere tests, and insuring a very humid atmosphere. In dry tests this was removed. An atomizer throwing hot water, was used without success, as was also small amounts of live steam. The special burner was modified so that small amounts of gas could be used with a low flame and consequently the rise in temperature in the oven was necessarily extremely even and slow. The gas pressure proved to be too strong and a pressure reducer was therefore devised to reduce the gas pressure from eight ounces to one-half ounce. A good grade of machine oil was substituted for the water which is ordinarily used in such a pressure reducer. The regulator was adjusted until the pressure was sufficiently reduced to require no further attention as the machine oil does not evaporate. A large Mithoff hygrometer, reading direct, was used to register the percentage of moisture present. These readings were checked by the use of a wet and dry bulb thermometer and the results were calculated from the psychrometric tables of the United States Weather Bureau. A wet bulb thermometer will not register the minimum temperature correctly, unless the air is circulated around it. To obtain this circulation some device that will circulate the air around the wet bulb thermometer is required. An electric bell was modified for this purpose by removing the ball from the vibrator arm and replacing it with a small fan made from light, soft wood. This modified electric bell was operated with two dry batteries, and the rapid vibration of the fan blade circulated the air around the base of the thermometer.

The following list of species were used in these experiments:—

Silvanus surinamensis L.
Cathartus advena Walt.
Cathartus gemellatus Duv.
Læmophlœus minutus Oliv.
Trogoderma ornatum Say.
Attagenus piceus Oliv.
Tenebrioides mauritanicus L.
Sitodrepa panicea L.
Tribolium confusum Duv.
Tenebrio molitor L.
Plodia interpunctella Dubn.
Ephestia kuehniella Zell.
Calandra oryza L.

In the oven experiments most of the different species of insects succumbed at a slightly lower temperature when using moist heat than when using dry. The rice weevil (*C. oryza*) seemed to be especially susceptible to heat in a moist atmosphere, repeated tests showing that 3° C. to 4° C. less are required to prove fatal than when using dry air. Several of the other species died at practically a uniform temperature, regardless of the presence or lack of moisture. Considerable variation in the moisture content of infested material and in the activity of the insects infesting the same was also experienced. In the tests, most of the insects became very active at 40° C. to 43° C., especially the adults. This activity increased with the increase in

temperature until they became frantic in their efforts to escape. The high temperature speedily caused death. A lowering of the temperature previous to attaining the fatal degree generally brought about almost normal actions though, in some cases, a period of inactivity resulted before normal activities were resumed. This period of partial inactivity sometimes lasted several days before all of the functions were performed in an entirely natural way. In many cases, especially when a dry atmosphere at 47° C to 48° C. was used, the insects surviving the test would die several hours to several days later. In making a large number of tests it was observed that very often the different stages of the same species, succumbed at slightly different temperatures. In every case, as far as these experiments extended, the egg stage was the first to be destroyed. The resistance of the stages varied with the insect, but in general that stage which endured the greatest heat, or sometimes survived, was usually the dormant one in which the insect passes the winter. In those cases where all stages occur at all seasons, little difference in resistance could be discerned, but in the case of *T. ornatum,* the partially grown, or young larva, readily survived a temperature which proved fatal to the other stages.

Silvanus surinamensis was not much more susceptible to moist than dry heat. In a large series of experiments the fatal temperatures with moist and dry heat were not more than 1° C. apart, and the average was a little less than .41 of a degree Centigrade. The egg stage was killed in every case by 44° C. to 45° C.; 44° C. being the average temperature which destroyed life in the egg. Larvæ, pupæ and adults died at 46° C. to 48° C., the pupæ proving more susceptible to heat than larvæ or adults. The beetles withstood treatment longer, and also a slightly higher temperature. This beetle is almost a universal feeder, being able to live and reproduce in wheat, flour, corn meal, breakfast foods, crackers, currants, raisins, dried fruits and nuts of several kinds, if the shells are broken. With the exception of *Tribolium confusum*, it is probably the most common and destructive pest affecting cereal products and ground cereals. It is not partial to the end or corner of a package of cereal, as are some other species, but works through the entire mass, nibbling here and there and rendering all of it unfit for food.

Cathartus advena lives almost entirely on ground cereals, but may often be found in stored grain in company with other species of *Cucujidæ.* It rarely occurs in great numbers, but it is one of the common stored-grain pests. A moist, heated atmosphere kills this beetle at almost 1° C. lower temperature than when it is subjected to dry heat. Like *S. surinamensis*, it does not always recover from the effects of being subjected to a dry, heated atmosphere, often dying several hours

or days after the test. While it may not be killed outright by the heat, certain of its tissues, or organs, seem to become fixed, failing to perform their normal functions, and this causes death some time after the actual treatment.

Cathartus gemellatus, a closely related species, seemed to be affected similarly by heat; the fatal or killing temperature being the same, and the final results very nearly the same.

Læmophlœus minutus. These tiny beetles are hard to kill, almost 50° C. being necessary. The larvæ and pupæ were killed by 48° C. to 49° C., and no eggs hatched after being treated to 45° C. These small beetles are among the most difficult of the *Cucujidæ* to kill with high temperature, but almost no difference could be detected between the effects of moist and dry heat, the average difference in effective temperature being less than .25 or $\frac{1}{4}$ of a degree Centigrade. They commonly occur in flour, corn meal, cereal products, nuts, raisins and sometimes in dried fruits. They are so small and flat that they easily find entrance beneath the lids of all but the closest fitting canister tops, and thousands of individuals will often be found in a few ounces of food material. Several scores of individuals were found living in a chestnut from which the larvæ of *Balininæ* had emerged.

Trogoderma ornatum. The young larva of this *Dermestid* survived most of the tests, being seemingly much better fitted to resist extremely high temperatures than the other stages of this insect. It is much more resistant than any other of the species of cereal pests, as far as these have been tested by the author. The young larvæ become very active at 45° C. to 47° C. and continue their activities with irregular periods of inactivity until a temperature of 52° C. to 53° C. is attained. At 52° C. the young larvæ begin dying and usually are all dead before a temperature of 53° C. is attained. The beetles, pupæ and full grown larvæ were readily killed by 48° C. to 50° C. Moist atmosphere at 48° C. to 50° C. was fatal to the beetles, pupæ and full grown larvæ, but was no more effective than a dry atmosphere at similar temperatures. This species will subsist on corn meal, popcorn, sweet corn, nuts, feathers, skins, museum specimens of birds, mammals, insects, etc., furs, woolens, and is almost a universal feeder.

Sitodrepa panicea. The drugstore beetle is readily killed in all stages by 47° C. to 49° C., there being apparently no difference between the effect of a heated moist or a heated dry atmosphere. This beetle is of special importance as it is truly a universal feeder on dried herbs, roots, grains, cereal products, and drugs of many kinds. It is a pest of the herbarium and museum, besides being a common drugstore pest. It may eat leather, if no other food is present, and it has, in a few instances, almost destroyed horn scoops in boxes of drugs where the

scoop was covered with some drug for several months, and was not disturbed or moved.

Tenebrioides mauritanicus and *Tenebrio molitor*. The cadelle beetles are readily killed by 48° C., but the larvæ will often live until a temperature of almost 50° C. is attained. Moisture, or the lack of moisture in the atmosphere, does not seem to make any radical difference. The beetles of the cadelle, and also the darkling beetles, are killed by 47° C. to 48° C., but the larva of the former is more resistant and a higher temperature is required to destroy it. The larvæ of *T. molitor*, however, are more susceptible to heat in the presence of moisture than in its absence. Larvæ of *T. molitor* died at 46° C. to 48° C.

Tribolium confusum. The confused flour beetle is killed by 48° C. and the moisture content of the heated atmosphere seems to make very little difference in results. The slight difference in favor of the moist atmosphere is not sufficiently large to be of any advantage. In fact, taking into account the slower rise in temperature in moist air, the obstruction to the penetration of heat, and the consequent difficulty in obtaining a fatal or killing temperature, the dry atmosphere is preferable. The eggs, larvæ and pupæ are all more readily killed than the adults by the dry heated atmosphere. The adults recover rapidly from the effects of heat if they survive. The larvæ and pupæ sometimes survive the dry-heat treatment if the killing temperature is rarely or scarcely attained, but all die subsequently, even if transferred to a moist food supply. Larvæ and pupæ which survive a similar temperature in a moist atmosphere seem in no way inconvenienced by the treatment they receive, and develop normally. When the confused flour beetles are placed in the oven with a quantity of flour, or middlings, they leave the surface of the material, burying themselves in the cooler parts of their food supply as the temperature rises. When the mass begins to heat through, they attempt to escape the heat by crawling out of the material and soon die on the surface of their food at 47°C, to 48°C. The time required for the heat to penetrate the middlings, or food supply, varies with the material to be treated, its moisture content and also with the intensity of the heat. Flour on the metal bottoms of conveyors will heat through in 3 to 5 hours if the surrounding atmosphere is heated to a temperature of 55°C. to 60°C. The flour in the conveyors is often 2 or 3 inches deep, so these insects would not be affected by any fumigants excepting the heavy penetrating gases, and would need to be subjected to these for long periods.

Plodia interpunctella. The Indian meal moth is readily killed by high temperature, 46°C. often proving fatal to larvæ, pupæ and adults, if continued for several hours. A habit of this species, that of working

near the surface of infested material, especially ground cereals, and also of pupating in similar places or near the confining walls, makes heat an especially effective means for destroying these insects. Dry heat was more effective than the moist heated atmosphere, as some of the individuals would recover after being subjected to a moist heated atmosphere; the heat and lack of moisture seemingly fixing the tissues more readily than when moisture was present.

Ephestia kuehniella was readily killed by either a moist or dry heated atmosphere. The eggs and young larvæ were destroyed if actually subjected to 45°C. to 46°C. for 15 to 20 minutes. The other stages were killed if subjected to 47.5°C. to 48°C. for a similar period of time. In many respects it resembled *P. interpunctella* in the effects of heat treatment. Its habits of living in the machines, elevators, spouts and conveyors in the center of the mill, make the dry atmosphere high temperature a very effective means for its control.

Conclusions and Practical Applications

The practical value of high temperature at 48°C. to 50°C. for the destruction of pests affecting cereal products is much lessened when the heated atmosphere contains moisture in proportions greater than 40 per cent to 50 per cent. In practical work, if the moisture content of the heated atmosphere remains constant, or is greatly increased as the temperature rises, an increase, proportionally, in the amount of radiating surface will be necessary in order to maintain and raise the temperature to the fatal or killing point. Throughout the series of experiments, the extreme difference in the quantity of gas required to heat the oven during a dry heat test and to heat it during a moist heat test was especially noticeable. The most careful estimates, based upon the pressure of gas and the rapidity of its flow through a known diameter opening, indicated that the extremely moist atmosphere tests sometimes require almost twice as much gas as the extremely dry atmosphere tests. Careful measurements with adequate instruments may discredit these estimates in part, but that an extra amount of radiating surface is required, or that an excess of fuel is required to heat the moist chamber, cannot be doubted. The latent heat absorbed in vaporizing water accounts for these results. A fairly moist atmosphere at 47°C. to 50°C. will prove fully as effective as the dry heated atmosphere, but is not practical for use because of the difficulty in obtaining 50°C. under moist conditions. The excess of radiating surface required to heat the buildings to the killing temperature, increases the cost of the heating plant, but sometimes it may be necessary. All leaks in the heating system allowing water or steam to escape into the rooms being heated should be repaired, especially if

the amount of radiating surface approaches the minimum. Oven tests can only be taken as indicative of the general results that should be obtained in practical work in mills. Definite statements based on a specific laboratory test cannot be relied upon as general and the conclusion must be reached as a whole, after allowing for normal variations. The fact that a moist atmosphere at a high temperature is very effective for the control of a few cereal pests, does not make it preferable to dry heated air for practical use in a commercial way. The excessive amount of radiating required to produce a killing temperature under moist conditions makes economy of equipment a much more important factor. It also means the choosing of a dry, warm day, as the time to heat up the average flour mill. Leaks in the heating system also mean almost sure failure unless they are extremely small. Very few of the species of insects treated were more seriously affected by the moist heated atmosphere than by a dry one, and in those cases where the former was effective at a lower temperature, the penetration or conductivity did not appear to be as rapid as in tests of the latter kind. A further deterrent to the practical use of a moist heated atmosphere is that the least injurious of the flour mill pests are the only ones advantageously controlled by this treatment. The rice weevil is an exception, as it succumbs in a moist heated atmosphere at 3°C. to 4°C. lower temperature than in a dry heated atmosphere.

Rice mills could readily be treated by the heat method and the rice weevil thus destroyed. In case of reinfestation, the treatment could be repeated and much injury prevented. The cost of treating once every month would not be prohibitive. If the flour, or cereal mill, is so located that it is very moist during the summer, special provision should be made for abundant radiation so that the mill can be readily heated to the required temperature.

Summarizing our conclusions, oven experiments demonstrate that 50°C. to 55°C. kills all stages of cereal insect pests if they are actually subjected to this temperature for one to two hours. Further than this, in practical work, moisture conditions are extremely important and must not be overlooked, as failure to obtain the necessary temperature is often due to lack of sufficient radiating surface to overcome the excessive moisture conditions. Because of the more rapid radiation obtained, the use of steam at 50 to 60 pounds pressure will give results superior to those gotten with 8 pounds pressure with one fourth more of radiating surface.

A steam pressure of 100 pounds can be used if the heating system is constructed of new piping. However, considering the danger of a break in the average heating system with cast radiators, or second-hand pipe coils, 50 to 60 pounds is the maximum steam pressure that

should be used. The temperature of steam at different pressures is about as follows:

10 lbs.	115°C.	60 lbs.	153°C.
20 "	126°C.	70 "	158°C.
30 "	135°C.	80 "	162°C.
40 "	142°C.	90 "	166°C.
50 "	147°C.	100 "	170°C.
55 "	150°C.		

It is thus seen that the rise in temperature from 10 pounds to 55 pounds is much greater than from 55 pounds pressure to 100 pounds. Maximum economy of heating will, therefore, be obtained by using a pressure of about 50 to 60 pounds, since this will give the temperature necessary to kill, rendering it both unnecessary and wasteful to go higher.

Furthermore, in heating work, no allowance has hitherto been made for the differences in heat conductivity of the various building materials. When we have taken all of the aforementioned points into consideration, definite factors for proportional amounts of radiation will be estimated for the various kinds of buildings, basing these factors on the results obtained in a large number of practical experiments

The records of a few sample oven tests are appended:

MOIST HEAT

Time	Temperature C.	Moisture Per Cent
8.00	20	40
9.00	25	48
9.00	27	57
10.00	29	60
10.30	31	65
11.00	34	66
11.30	37	68
12.30	40	69
1.00	42	69
1.15	43	70
1.30	45	71
1.45	48	70
2.00	49	70
2.30	50	70
3.45	50	70
4.00	50.5	70

C. oryza. Larvæ and adults.

Some beetles apparently dead at 43° C. Many were dead before a temperature of 45° C. was attained. Larvæ removed from grains of corn, or exposed to the heat, were also dead at 44° to 45° C. *S. surinamensis.* Adults and larvæ.

Both stages died between 46° C. and 48° C.

DRY HEAT

Time	Temperature C.	Moisture Per Cent
8.00	27	34
10.00	36	28
10.30	42	26
11.00	42.5	25
11.10	43	24
11.20	43.5	25
11.30	44	23
11.45	45	22
12.00	46	23
12.15	47	24
12.45	48–	25
1.00	49	25
1.15	49	24
1.30	49.5	23
1.45	50	23
2.00	50.5	23
2.30	51	22
2.45	51.5	21
3.00	52	20
3.15	51.5	19
4.15	49.5	18
5.00	48	16

C. oryza. Adults, beetles died at 47° C. to 48° C.
S. surinamensis. Adults died at 48° C. to 49° C.
Mites *T. americanus*, were killed by 47° C.
T. ornatum. Larvæ half grown, adults and pupæ. Half grown larvæ died at 51° C. to 52° C. Pupæ and adults killed by 50° C.

THE WESTERN CORN ROOT WORM

By George G. Ainslie, *Entomological Assistant*

So many of the pests of orchard and field crops in the north and west have come, by importation and diffusion, from the east and south, it seems but just retribution that at the present time one of the well-established pests of corn in the west, *Diabrotica longicornis*, the Western corn root worm, is invading the southeast from its original headquarters in Illinois and Missouri.

Prof. F. M. Webster has followed this species from the beginning of his entomological work, a period of forty years, and has watched its spread from an area, at first apparently small, in the prairies of Illinois until, at the present time, it "occurs from Nova Scotia southward to Alabama and Mexico, westward to southern Minnesota and South Dakota and thence south to southern New Mexico." Apparently it has not yet completed its travels, for the writer, within

the past year, added to its previously reported limits of distribution in southern and eastern Tennessee, northern Alabama and eastern Kentucky.

Although the identity of the original food plant of this beetle is as yet an unsolved mystery, corn now seems to be its sole dependence. This fact in itself affords a strong hope of relief from its ravages. Crop rotation, where possible, had proved almost without exception, a complete remedy. There yet remains, however, a problem to be solved. Along the Cumberland and Tennessee Rivers in Tennessee and northern Alabama and along the Arkansas, Mississippi and Ohio Rivers as well as many of the smaller tributaries of each, are large areas of rich bottom land subject to an almost certain annual overflow. This excess of water seems to have no deleterious effect whatever on the eggs which pass the winter in the earth of the corn fields. In one case which came under the observation of the writer, a portion of the bottom land along the Duck River in middle Tennessee was under water eleven times in one winter, each time for from 2 to 12 days. The larvæ were as numerous the following summer in this portion as elsewhere.

This overflow does, however, prohibit the growing of any but summer crops. The present southern limit of distribution of the species is within the cotton belt and in this district cotton and corn can be alternated on such lands. Farther north, the systems of farming generally followed demand that corn follow corn in the bottom land. Here it is that these larvæ do, and will continue to do, damage until some crop can, occasionally at least, take the place of corn, or some other method of control can be found.

The life and seasonal histories of the species have been almost completely worked out in Tennessee and found to be substantially the same as farther north. There is but one annual generation, the eggs for which pass the winter in the earth. They are laid in late July, August and September in the ground about the bases of the corn plants, especially in the small crevices among the brace roots. They hatch in late May or early June of the following year and the larvæ are most active and injurious in late June and early July. A drouth at this time will increase the resultant damage to a considerable extent. The beetles begin to appear in July and, in infested fields, are to be found in countless numbers during the following two months, feeding on the fresh corn silk and pollen. The most serious damage, of course, is caused by the larvæ, which, by feeding on and in the small roots weaken and dwarf the plant, sometimes to such an extent that it may be easily discerned, at others only enough to reduce its yielding power without deforming it. When sufficiently numerous,

the beetles cause serious injury as well as the larvæ. The corn crop for the year 1910 was almost a total failure in the Duck and Tennessee River valleys in middle Tennessee. The ears developed good size but, because the silk was eaten off by the beetles as fast as it appeared, pollination and fertilization were interfered with and many cobs bore but a few scattered kernels or consisted mainly of a long naked tip which never filled.

The structure and habits of the newly hatched larvæ have never been observed. It is not known how far or fast the larvæ at this stage are able to travel through the earth. We have at the laboratory at Nashville, Tenn., several hundred eggs which we are attempting to carry alive through the winter for the purpose of studying these particular questions. These eggs were obtained from beetles kept in captivity in vials and supplied with fresh corn silk for food. The eggs are so small and laid so scatteringly that after the field has once been plowed or disked or covered with water, to find them would make the hunt for the proverbial needle in a haystack seem a bit of child's play.

It behooves all entomologists, especially those of the Gulf and South Atlantic states, to watch for this insect and give warning of its approach. Otherwise it may cause widespread loss before the farmer realizes the cause.

RED SPIDER CONTROL

By E. A. McGregor

The common red spider of the United States has been accepted as *Tetranychus bimaculatus* since Harvey distinguished it by that name in 1893. Professor Berlese of Italy upon a few occasions has identified material of the *bimaculatus* type from this country as the European species *telarius*. It is with great hesitation, however, that Berlese's determination should be accepted since his published figures of the specific characters of the European species show a very different type from that exhibited by the American species.

With the exceptions of limited occurrences on fruit trees in western Colorado, and of considerable injury to hop fields in central California, no red spider complaints of a serious nature have come to our attention other than from the southeastern portion of the cotton belt. It is concerning its occurrence on cotton, then, that the present discussion of the pest is primarily centered.

Since the red spider is not an insect, it would be fair to presume in advance that certain factors bearing on its control should be radically

different from those commonly obtaining in the realm of insect pests. This, moreover, is found to be the case. The red spider is a gregarious, non-flying, non-hibernating, suctorial, phytophagous pest. It differs from the typical insect pest in that it remains active through the winter, is incapable of dispersion by flight, and in the limitation of the individual in its feeding operations, practically, to the immediate scene of its birth. The red spider, then, from the standpoint of biological characteristics, is to be likened most, perhaps, to the homopterous Hemiptera as a group and, naturally, the direct combative measures employed against the mites are somewhat similar to those used against such families, for example, as the Aphididæ and Coccidæ.

The absence of flight in the case of the red spider is a factor working greatly to the advantage of the agriculturist. It is a handicap against rapid dispersion which, try as it may, can never be overcome by the group. The means of spread are chiefly three:—first, through the agency of accidental transportation by other creatures; second, by the actual locomotion of the individuals themselves; and third, by hydro-locomotion.

It has long been recognized that larger insects, birds, domestic animals (especially plow animals at the time of cultivation), etc., served occasionally to transport mites from plant to plant. This, however, I do not consider a potent factor in the serious spread of the pest. It has likewise been observed that red spiders travel from plant to plant along branches which are in contact with one another. Mr. Worsham, in his bulletin on the subject, emphasized this method as the only means of spread which he observed. It has been determined in South Carolina, however, that mites also travel on the ground from stalk to stalk, the average rate being about one inch per 15 seconds. It appears established, though, that the great bulk of continuous dispersion is effected mainly by means of travel from plant to plant across the interlacing branches.

It had been difficult until this year to explain, however, in what way isolated spots of infestation came to exist in fields rather remote from the presumed source of dispersion. Observations conducted the past season at Batesburg, S. C., by Mr. McDonough and myself, have brought to light a new type of dispersion which seems unique, and we have called it hydro-locomotion. This factor easily accounts for most cases of sporadic infestation. It has been known for years that heavy rains are effective in washing off many red spiders to the ground. It was taken for granted that these washed-off mites were thus destroyed and eliminated for all time. It is known now, however, from experiments of the past season, that nine hours complete submergence is necessary to insure the death of the red spiders by water. The appli-

cation of the hydro-locomotion idea comes about, then, as follows: Battered to the ground by a heavy downpour of rain, countless thousands of mites are carried along in the tiny streamlets which form at such times between crop rows, and may even find their way into the smaller creeks. Provided, thus, that the duration of submergence does not reach nine hours, or that the individual receives no fatal buffeting on its journey, it will shortly revive upon becoming stranded and establish itself anew—perhaps many rods from its place of detachment.

The activity of the red spider during the winter constitutes a two-horned factor, the relative economic status of which is not at once determinable. The fact that the adult mites are not compelled to hibernate bepeaks graphically the hardiness of the species, and holds out little encouragement for the decimation of the pest through the inimical agency of minimum temperatures. On the other hand, the occurrence in the winter of the mites in the active state enables the planter to concentrate his combative efforts at a time when the pest is reduced in number to a minimum. In short, this condition leaves the red spiders in the winter period where they can be easily found and combated by human agencies if so desired. It is a question whether more good or more harm comes, economically, from the attribute of winter activity on the part of the pest.

The non-roving disposition of the red spider is another characteristic which is both to the detriment and the advantage of the farmer, depending on the viewpoint. From the fact that mite individuals usually attain maturity on the identical leaf which harbored them at birth, and are suctorial in nature, it is obvious that spraying operations are complicated to the extent that the applications, to be effective, must be made in such a way as to come in contact with every portion of the infested foliage. This necessarily increases the cost of spraying until the outlay constitutes a considerable proportion of the value of such a comparatively non-valuable crop as cotton. On the other hand, the aversion of the red spiders to moving about has a retarding influence on dispersion and, although it tends to concentrate the attack where present, is decidedly unfavorable to the rapid dissemination of the pest. The aggregate result of the non-roving attribute, coupled with the absence of the power of flight, is that infestation is never continuous over large areas, but is restricted to limited areas with their respective sources as centers. These infested areas occur, figuratively, as countless islands in a sea of immunity. From this, it is easy to see that, to a great extent, every man's problem is virtually his own. Hence, if infestation comes from a certain spot upon one's premises, proper attention to such a source will yield satisfactory results in spite of the negligence of one's neighbors.

The distribution of the red spider is very general. It has been reported from Maine to Florida, and from South Carolina to Oregon, and it doubtless occurs in every state of the Union. What the original host plant of the common red spider was, seems impossible now to determine. The pest is a very omnivorous creature, having been recorded at Batesburg from 130 hosts. It is most abundant ordinarily upon the English violet, sweet pea, hollyhock, morning-glory, bean, dahlia, tomato and Jerusalem-oakweed. The commonly cultivated English violet seems to serve as the winter host for the vast majority of mites in urban localities. The same mite species has been found also on species of wild violet well removed from domestic habitations. The ubiquitous pokeweed serves as an early seasonal host, but is probably chiefly in the nature of a secondary host rather than that of a normal winter food plant.

The usual time of the first conspicuous appearance of the red spider in cotton fields is about June 30. The pest establishes itself some time previous to this, however, and it is seldom difficult to find migrated females on nascent seedlings in exposed situations. Practically all occurrences in urban localities have been intimately associated with cultivated violet plants and doubtless originated from them. On the other hand, with very few exceptions rural cases of infestation are traceable to pokeweed stalks growing at the field borders or on the terraces.

The description of a particular rural occurrence will serve to illustrate a typical case of origin from pokeweed. In this instance the infestation was seen to grow increasingly severe as one approached a certain point on a terrace. Converging from all directions toward this center, infestation clearly became heavier until an area was reached where the plants were denuded of foliage. Precisely in the center of this area there grew a large pokeweed stalk. It was "alive" with mites and was lightly festooned with their webbing.

It is not yet entirely established whether or not the poke plant functions as a true winter host. The plant is a perennial, and the stalks die to the ground in the late fall. At the base of the dead stalks are to be found the soft, fleshy roots which are very succulent. In addition, at the crown of the roots, at about the ground level, there are always to be found through the winter months the tender dormant buds which give rise to the stalks of the following spring. Upon November 23, following several severe frosts at Batesburg, S. C., a few mites were seen apparently feeding on these winter buds.

In South Carolina there are usually about sixteen generations of red spiders each season. In 1911 there were seventeen, in 1912 there were sixteen and in 1913 there were again sixteen successive broods

of mites as nearly as could be determined. The time required for the development of a generation varies with the prevailing temperature, etc., but ten days is the usual period necessary under summer conditions. It is true that adult females continue to deposit eggs intermittently throughout the winter, and many of these eggs, even, may hatch during the occurrence of mild periods of winter weather, but practically no instar development takes places after the middle of October until the advent of vernal conditions. The extent of the mortality arising from adverse winter conditions is largely conjectural. It is very probable that most individuals of the immature stages are killed during the winter, but a very high percentage of the mature mites doubtless survive.

Before becoming established on cotton, one or more preliminary migrations usually occur. In the case of mites overwintering on cultivated violets, they usually become so densely abundant on this host that they cause the plants to wither and die to the ground by early May. This forces a migration which carries the adult females to a large variety of nearby plants—both wild and cultivated. These secondary hosts in turn become overrun by mites and further migrations become necessary. It is these later movements which, as a rule, result in the discovery of cotton by the red spiders, and which most frequently occur during the latter half of May.

The appearance of red spider work on cotton is doubtless familiar to most entomologists of the South, as it also is to many cotton planters. The presence of the pest on cotton is first revealed by the appearance on the upper surface of the leaf of a blood-red spot. As leaves become badly infested they redden over the entire surface, become distorted, and drop. The lower leaves usually are first attacked, but infestation spreads upward until often only the bare stalk and one or two terminal leaves remain. Such plants almost invariably die, but at any event always fail to mature fruit.

It may be said that large fields are probably never completely damaged by this pest, but smaller fields frequently become wholly affected. A thorough examination of all fields within one mile of the center of Leesville, S. C., was made with a view of determining the exact status of red spider infestation at one specific locality. In all, ninety-nine fields were examined as carefully as possible, and about 74 per cent of the fields were found to be infested to some degree. This occurrence was perhaps more severe and more general than is usually the case. Probably the most severe case in this locality (and typical of a very heavy infestation) was one which had its origin in a large clump of badly infested pokeweed stalks which grew at the edge of a barnyard. The pest spread fan-like until it reached in one direction

a point 600 feet from the source. The final affected area, semi-circular in shape, comprised thirteen acres, and within its confines the occurrence was general. While such a case as this is unusual, four-acre or five-acre spots with from 25 to 100 per cent damage, are frequently to be seen.

As to the control of this pest, through the operation of natural agencies, there is considerable to be said. As was previously intimated, climatic conditions influence the development of the red spider to a marked extent. During times of little rainfall and high temperature reproduction goes on by leaps and bounds; on the other hand, long, heavy rains work havoc to the red spider population. In spite of the fact that the mites inhabit the underside of the leaves, many are washed off by rains and others are destroyed by the upward bombardment of sand particles which may always be seen coating the lower leaves after storms. In fact, it appears true that a few heavy rains, especially if they continue for some time, reduce, for the time being at least, the degree of infestation to a great extent. As noted before under hydro-locomotion, however, we have demonstrated during the past season that, although a heavy temporary decimation of the pest is occasioned by heavy rains, many of the washed-off adults may be carried considerable distances in the surface water at these times only to revive upon stranding and to establish new colonies remote from the scene of their rearing. Thus rains, which for decades have been accepted unchallenged as an unmitigated blessing to mite-infested crops, are, in the light of this recent discovery, to be held equally responsible for potential powers in quite the opposite direction. The composite effect of these opposed economic rain factors is, doubtless, that of greatly decreasing the percentage of infestation while at the same time considerably extending distribution.

The effect of freezing weather has been previously touched upon. From observations made during the winter, it is doubtless true that most of the mites in the young stages are killed by the minimum temperatures. This naturally prevents any considerable winter increase, and, in addition, a very small percentage of adults may also perish. It must be borne in mind, however, that the red spider is remarkably adapted to withstand low temperatures. To illustrate this point it is interesting to record an observation made at Washington, D. C., during the severe winter of 1911–1912. Adult red spiders collected on a morning following a night temperature of $-13°$ F. were brought into the indoor atmosphere whereupon the majority of them rapidly revived.

In the case of each of the seasons 1911, 1912 and 1913, during which the red spider has been under observation at Batesburg, a sudden

decimation of a more or less complete nature has occurred within the ranks of the pest. During the seasons of 1911 and 1912 this mite decimation occurred mainly in the last two weeks of August. In the case of the past season, the decimation occurred during the early days of July, or nearly six weeks in advance of the case of the two previous years. The phenomenon, indeed, happens suddenly, and the agencies which work to produce it are unquestionably of great economic importance. The ageing and toughening of the leaves at about this time may cause some mites to desert cotton for other plants, but the factor of real importance is the abundance of several species of insect enemies which gain dominance at just this time. Following are the beneficial species of particular economic importance which have been observed at Batesburg during the last three seasons.

Careful observations have convinced us that the larva of a small Itonid fly occupies first rank among the enemies of the red spider. The species—*Arthrocnodax carolina*—was very recently described by Doctor Felt from material sent to him from Batesburg. This predator appears to confine its attack entirely to the eggs of the red spider. It usually becomes noticeable first about the middle of June and multiplies rapidly until toward the end of July, when the species becomes so superabundant that its checking effect on red spider infestation is most conspicuous. Too much emphasis cannot be placed on the economic value of this species, and to its activitiy is probably largely due the seasonal decimation of the red spider. It has been collected from Virginia, North Carolina, South Carolina, Georgia, Florida and Alabama and has, evidently, a wide distribution. It is interesting to note that this predator becomes heavily parasitized later in the season by a minute Chalcidid fly which has been identified by Crawford as *Aphanogmus floridanus*.

The insidious bug, *Triphleps insidiosus*, of the family *Anthocoridæ*, probably ranks second to *Arthrocnodax* as a predator upon the cotton mite. It appears somewhat earlier in the season than the latter, being seen occasionally as early as the middle of May. Both the nymph and the adult stages prey upon the red spider, the former feeding chiefly upon the mite eggs, while the latter attacks adults and immature stages.

The small, dark Coccinellid species—*Stethorus punctum*—was very abundant through July, and in the case of some badly mite-infested jump-vine leaves, it was responsible, almost unassisted, for the extermination of the pest. This species ranks close to *Triphleps* as a mite predator.

A species of lace-winged fly, *Chrysopa oculata*, probably ranks next in order among the enemies of the red spider. They become plentiful,

ordinarily, about June 15, and the larva are active among cotton mite colonies. During September a large series of Chrysopa cocoons were bred in the laboratory, and it is interesting to note that at least seven species of parasites occurred so plentifully that over 48 per cent of the Chrysopids were attacked.

During the month of July a species of thrips was observed to be actively predaceous upon the red spiders. This species has been identified as *Scolothrips sexmaculata* by Mr. Morgan. It was exceedingly abundant on infested cotton at Leesville, S. C., on July 25, of the present year, and practically controlled some belated occurrences of the pest in several observed fields.

In addition to these five principal predators, there might be mentioned a Syrphid larva, several species of lady-beetles, and one or two other thrips species which have been seen occasionally in or about red spider colonies. It has not yet been determined whether there are any internal insect parasites of the cotton mite.

An extremely interesting association of "cause and effect" seems to have been established governing the fundamental origin of the great fluctuation in degree of infestation occurring from year to year. The winter of 1911–1912 was the severest in South Carolina for many years. Hence it might be expected that the following season would be a mild one, from the standpoint of injury by the red spider, through the assumed heavy mortality of the pest during the winter. On the contrary, as has been stated before, the 1912 occurrence was the severest on record. The only possible explanation appears to embrace two suppositions. One is that the adult red spider is little susceptible to extreme cold. The other is that the insect enemies of the mites succumb much more readily to minimum temperatures than do the mites themselves. Both of these hypotheses are sustained by all of our observations. Naturally, then, a severe winter is precisely what would most favor the subsequent increase of the red spider through the destruction of its insect enemies. Conversely, an abnormally mild winter, free from decidedly low temperatures, would furnish conditions most favorable for the survival of the repressive species, and the infestation for the following season would be mild. Thus, if this rule is unerring, it becomes obvious that the influence exerted indirectly upon the red spiders by pre-seasonal conditions is potentially greater than that of other factors operating during the active season.

Remedial Measures

Prevention

From the abundant experience of the last three years we have been forced to the conclusion that the eradication of the red spider must be

accomplished through preventive efforts rather than repressive, if it is to be economically effected. In the case of certain of our worst crop pests there exists at some stage in their life-cycles a condition or habit which constitutes a vulnerable point of attack. At such times of assailability the agriculturist is enabled to execute control measures both with comparative ease and dispatch. In the case of the red spider, however, no such vulnerable stage occurs. One generation rapidly follows the other with monotonous regularity and homogeneity. The stages are alike in structure and behavior, the eggs are impervious to the action of sprays, and the feeding habits remain identical from the time of hatching till death. The location of the mites through the winter and spring, their preference for the cultivated violet and the pokeweed, and the manner of dispersion of the pest, however, lead to the presentation of the following cultural expedients.

Clean culture.—First among preventive measures against the red spider is doubtless that of exterminating the weeds and plants which breed the pest. Pokeweed, Jerusalem-oakweed, Jamestown weed, wild blackberry, and all border weeds and underbrush about fields should be burned or grubbed out during the winter or early spring, and should be kept down throughout the summer as far as possible. This plan has been tested in several instances and has given complete immunity the following season. Too much emphasis can not be placed on the importance of destroying, so far as possible, all weed growth—especially the pokeweed, which should be grubbed out by the roots.

Control on violets.—As before stated, most cases of infestation in urban localities have their origin in borders of cultivated violets growing in nearby house yards. In several instances violets adjoining fields of past severe annual infestation have been thoroughly sprayed, with the result that no red spiders appeared subsequently in these fields. The objection to this treatment is the failure on the part of the average person to persevere with the spraying until the pests have been entirely exterminated. The most satisfactory procedure in such cases consists in the removal and destruction of the offending violets.

Varietal immunity in cotton.—From several tests conducted in different fields with numerous standard varieties of cotton, and from the information volunteered by farmers from many portions of South Carolina, data have been accumulated which clearly indicate that certain varieties are susceptible to red spider infestation, while others exhibit considerable immunity. Careful observations on a considerable number of varieties grown for the purpose showed that Dixie,

"Wilt Proof," Toole, Peterkin, Broadwell, and Cook suffer most (in the order named) from the attack of the pest, while Hite, Russell, Summerour "Half and Half," and Cleveland showed the greatest immunity of all the varieties investigated. Further investigation of this feature of the problem will doubtless throw additional light on the relative desirability of the common cotton varieties from the viewpoint of immunity.

Spacing.—It has been claimed by one investigator, who held that intrafield dispersion occurred only directly from branch to branch, that wide spacing of the stalks, by preventing the interlacing of the branches, would prevent the spread of the red spider through a field. Experiments at Batesburg have shown that the red spider commonly travels between plants upon the ground. Thus, although dispersion might be slightly impeded through the adoption of wide spacing, the futility of this measure becomes evident in view of the regular occurrence of terrestrial travel.

Time of planting.—There is yet much doubt as to the relative advantages of early and late planting. Extremely early planting naturally permits the plants to develop a maximum growth of weed and fruit by the time of serious mite appearance. It is noticeable that plants of considerable size are rarely killed by the pest, nor are well-advanced bolls commonly shed from infestation. On the other hand, several fields about Leesville, S. C., which were planted as late as June 20, seem to have largely escaped the infestation which was so general at that locality. Late planting, however, is almost universally objectionable to the farmer, since in ordinary seasons it results in a reduction of the yield.

Rotation.—In an effort to test the rotational value of other crops, numerous field crops have been planted in or near infested areas. In addition, frequent examinations have been made of a great many garden and vegetable crops in infested localities. Besides cotton, red spiders are known to occur not at all uncommonly upon the following field crops: Cowpeas, clover, corn, hops, and watermelon. They are also found frequently on the following garden crops: Peas, beans, onion, tomato, lettuce, okra, turnip, mustard, squash, beet, sweet potato, and strawberry. A really acute infestation on corn was seen at the height of the 1912 season. Cowpeas are particularly attractive to the pest, and sweet potatoes have been noted to be badly infested. Should an immune crop be found and employed, it is extremely probable that the pest would reinvade the fields upon the return to cotton culture with as great ease and quickness as it has done during any previous season, providing the sources of infestation were at hand. Rotation, then, does not promise to contribute toward the solution of the problem.

Effects of fertilizers.—A rather elaborate series of tests with fertilizers has been conducted in an attempt to determine whether the various applications assisted cotton to withstand the injurious effects of infestation. The result of these experiments have been negative and it has been impossible to deduce any definite conclusions.

Repression

We have just discussed cultural measures which may help to prevent infestation. We will now consider what may be done to combat the pest when it has already gained entrance to a field.

As before intimated, we believe in the efficacy of prevention rather than cure, in the case of the red spider. When once well established in a cotton field the pest is a difficult one to wipe out. That it is possible, however, to eradicate the pest from infested fields has been demonstrated beyond doubt, but in many cases the task is so tedious that only the most determined farmers will undergo the effort necessary to accomplish the extermination.

Removal of infested plants.—The experiment has been thoroughly tested of pulling up and destroying the first few plants which show infestation. In such cases the operation must be repeated several times. Great care should be observed in locating every plant which shows the characteristic red spots, and these must be carefully taken from the field and burned. If infestation has not advanced far, this treatment is usually effective, and a red spider invasion often may be thus "nipped in the bud" and entirely eradicated.

Occasional observation of instances wherein infestation had abruptly stopped at a much-traveled road suggested the idea of plowing a wide swath just outside the boundary of infestation. This was attempted in one case where the infestation had covered about two acres. A 10-foot ring was plowed around the spot, and all stalks, both in the swath and in the inclosed area, were immediately burned. Unfortunately the farmer did not make sure that he was beyond the outermost zone of infestation, and, consequently, a sufficient number of affected plants remained outside the pulverized barrier to continue, somewhat, the dispersion of the pest. This idea should be given further tests, as it seems there should be great efficacy in the operation, provided the swath is kept stirred frequently.

Insecticides.—In the course of the investigations on the cotton mite, almost two score of spray combinations have been thoroughly tested under conditions entirely natural. Since no substance was discovered which could be safely used to destroy all eggs in one application, it has been found necessary to spray twice, with an interval of six or seven days, so as to destroy the hatching larvæ. The killing ability of all these sprays was computed, and the percentages ranged from

100 to 0. The large majority of the compositions proved to be entirely ineffective against the red spider. A few proved to be deadly to the mites but were eliminated owing to the fact that they were injurious to the foliage. About eight sprays in all have weathered this process of elimination and can be recommended with confidence as efficient acaricides. These effective sprays are: (1) Potassium sulphid (3 lbs. to 100 gals.), (2) home-made lime-sulphur solution, (3) kerosene emulsion, (4) resin-wash, (5 and 6) miscible oil (uncombined and combined with "Black Leaf" tobacco extract), (7) "Sulfocide," and (8) flour-paste solution (diluted 1 to 8). From a rather extended use of these compositions it seems established that if one of these were to be used in preference to all others, it would probably be potassium sulphid. This insecticide commends itself from every standpoint—cheapness, simplicity of preparation, ability to kill quickly, and safety of foliage. Altogether it seems to be an ideal red-spider spray. It was found that 100 gallons, when applied as a misty spray, about sufficed to treat an acre of average-sized cotton at a cost of about 75 cents for the material.

Spraying outfits.—The sort of outfit to be used for red-spider spraying depends mainly upon the extent of the occurrence. Some have sprayed their score or so of affected plants with a 75-cent tin atomizer. While this instrument is very economical of liquid and throws a misty spray which penetrates and blows to all parts, it is not economical of time. The bucket pump and knapsack pump come into use in cases of considerable scattered infestation or for the treatment of a few high plants. The most economic outfit for a severe case involving several acres consists of a barrel pump carried through the field on a wagon. One man drives, one pumps, and one handles each sprayer (of which preferably there should be two). Thorough treatment of three or four acres per day is readily obtainable with this device. For safe work, however, this outfit should be used only on cotton of average or low size, as the passing wagon will injure large plants.

Necessity for thorough spraying.—Some dissatisfaction has been experienced among certain of those who have undertaken to check the ravages of the red spider by spraying. This can be understood on account of the extreme care which must be exercised in order to secure effective results. In the case of insects which devour the plant tissue, even the careless application of Paris green or lead arsenate to the top of the foliage is often effective. This is explained by the fact that such pests are constantly moving from leaf to leaf and will eventually eat some of the poisoned tissue. Moreover, these insects often eat entirely through the leaf, and hence it matters little whether the poison falls upon one side or the other. With the red spider, however, it is

altogether different. A contact insecticide is absolutely necessary, and, from the fact that the mite as a rule passes its entire existence upon the under side of a single leaf, it becomes plainly necessary in spraying to *hit the entire underside of every leaf* of an infested plant. It is obvious, therefore, that indifferent spraying is certain to yield unsatisfactory results. Furthermore, the absolute necessity for a second spraying to kill the hatched eggs adds to the difficulty. It is hoped that this discussion may clearly convey *the economy of prevention* of infestation.

In conclusion we will refrain, in this brief consideration, from an orderly summary or reiteration of the salient points herein contained. It should be emphasized once more, however, that the red spider, as a pest, presents phenomena of a biologic and economic nature which are rather unique. The winter activity of the pest, the rapid succession of many overlapping broods, the lack of flight, the extreme omnivorous and ubiquitous character, the limitation of dispersion chiefly to travel afoot and by water, the almost impervious protective web, the spray-proof character of the eggs, the restriction of infestation to the bottom of the leaves, the non-wandering nature of the individuals of the colonies, and, finally, the microscopic size of the creatures—all are characteristics which individually and collectively complicate the problem of control. A serious consideration of these factors cannot but impress one with the intricacy of the red spider's status within its environment.

THE GREEN SOLDIER BUG (NEZARA HILARIS)

By R. D. Whitmarsh, *Ohio Agricultural Experiment Station*

Occurrence and extent of damage. During 1911, peach growers along the Marblehead peninsula region of Lake Erie sustained a severe loss as the result of injuries caused by this insect. Although it has been commonly found in Ohio for many years, it had never been reported in any such abnormal numbers before, and so far as I am able to find out was never reported as a special enemy of the peach in this state. I understand *Nezara hilaris*, or more probably a closely related species, *Nezara viridula*, has at times done considerable damage to peaches in Georgia and oranges in Florida.

But little was accomplished during 1911 in determining the life history of this insect, as we were not informed of the severity of the attack until the first of September. On visiting the infested district the conditions were found to be fully as bad as one of the growers of peaches in that region had proclaimed them to be. He estimated his loss at fully $500 and others professed similar losses. No one seeing

the quantities of worthless, gnarled fruit lying on the ground could doubt their statements in the least. Many of the Elberta trees showed a loss of two, three, or more bushels per tree.

Character of injury. These bugs commence feeding on the small fruit during the last part of June and in early July, and continue working upon the fruit until late fall. They feed by puncturing the skin with the beak, and by sucking the juice from the flesh of the fruit. In a short time, a small droplet of gum appears at the injured point, which in time becomes irregular in outline, owing to the fact that the cells about the puncture are killed, thus making them incapable of further growth. The degree of irregularity, of course, depends upon the number of punctures. Where the fruit is badly punctured, it becomes entirely unsalable, while extra fine fruit showing but one or two punctures has to be graded lower, thus decreasing its value.

Injury of 1912, and note on life history. Practically no damage was done during the year, and so far as I was able to find out from the growers and by making a visit to the previously infested district, hardly a bug was seen. One egg-mass, however, was found of this species, while collecting at Wooster, on a leaf of *Viburnum prunifolium* (black-haw) the last week in June, which hatched on July 1. From this egg-cluster I was enabled to carry two specimens, a male and female, through five instars to the adult stage, which was reached on September 1 and 2.

Notes for 1913, and a further account of the life history. The past season, these bugs were reported as occurring in small numbers on peaches in the previously infested district along Lake Erie, but the damage done was but slight compared to that of 1911. While collecting in and about Wooster, I found them particularly abundant on wild cherry in the latter part of June, and afterwards on elderberry, black-haw and dogwood (*Cornus alternifolia*), thereby enabling me to work out the life history in detail, both in the field and laboratory. The first appearance of the adult form, after hibernating through the winter in protected places under leaves and loose earth, was about the middle of June. The time of appearance is undoubtedly controlled by the season, probably occurring a little later than usual the past year, as it was comparatively backward. I found five adults on June 11, on wild cherry, and after that date found them in abundance up until the latter part of June, when the number of adults seemed to decrease until one could hardly find a specimen after the middle of July. The decrease in adults was marked by a corresponding increase in the number of immature bugs.

The eggs laid by different females sometimes vary in color; commonly she desposits light, yellow-colored eggs, but occasionally will

deposit light-green eggs. This is an individual characteristic, the cause of which is unknown. The color of the eggs remains constant in each successive laying by the same female. From two to three days before hatching, both the yellow and green-colored eggs take on a pinkish shade which increases in depth until the cap-end becomes nearly red, just before hatching. The number of eggs laid by different individuals varies; one insect may deposit three clusters of eggs. The first laying is always the largest, usually consisting of between 40 and 50 eggs, although some individuals do not deposit nearly so many. The second laying of eggs contains commonly about half the number in the first, although this sometimes varies. The third cluster, when there is one, commonly contains from two to six eggs. They adhere to each other by a cement-like secretion deposited by the parent and are attached to the leaf by a similar substance. They are oval-shaped and are largest at the top, or cap-end. They measure about one-sixteenth of an inch high, by one thirty-second of an inch across. On looking closely, one will see a small circular cap, around which is a single row of rather stubby, clubshaped, spine-like processes. The eggs hatch in from seven to nine days. The period from the egg to the adult varies. The shortest period from the time of hatching of the egg to the adult stage, recorded during this season's experiments, was from July 23 to September 10, or a total of forty-nine days, the cluster of eggs having been laid on July 14. The longest period, which, by the way, was from this same egg cluster, was from July 23 to October 6, or a total of seventy-five days. The following is a record of the life history of the young bugs hatched from the above egg-mass. Eggs hatched July 23 during the forenoon, and the young nymphs remained in a mass beside the egg shells from which they hatched, without feeding, until 4.15 p. m., July 28, when they commenced molting. After having molted, they separated and started feeding on the berries, continuing to feed and resting at intervals until some time between 4.30 p. m., August 6, and 7.30 a. m., August 7, when most of them molted. The final specimen did not, however, molt the second time until August 8. August 13 two specimens molted the third time, carrying them into the fourth instar. They continued molting at intervals until sometime between 4.30 p. m., August 17, and 7.30 a. m., August 18, when the last two molted the fourth time and from this time on specimens molted at intervals until they had all molted the fourth time on September 2. On September 10, two specimens molted the fifth time, becoming adults, and the molting continued until the last specimen transformed some time between 4.30 p. m., October 5, and 7.30 a. m., October 6. This was, by the way, the latest record which I have for the maturing of this species in captivity.

After becoming adults, they continue to feed until cold weather, when they conceal themselves in some protected place, coming up on warm days, but returning to their hibernating quarters with each cold spell, and after real winter weather sets in, do not appear again in any noticeable numbers until the warm weather of the following year. The 11th of June was the first day of the past season on which I found any specimens. The scarcity of bugs up to this time, as I have previously mentioned, was undoubtedly due to the backward spring, as we did not have any real warm weather until the first of June. After this I had no trouble in finding the bugs. The latest date recorded for taking the adults, while collecting, is November 6; however, I did find one specimen resting on the wood-work in a breeding cage out of doors December 4; but I believe that most of the bugs seek sheltered places soon after the middle of October, as it is very hard to find any after that time.

Conical Grape Gall (*Cecidomyia viticola* O. S.). The characteristic gall produced by this species is reddish or reddish green, one-quarter to a third of an inch long and occurs on the upper surface, sometimes in numbers, of the leaves of various species of grape. It is not common though occasionally locally abundant. The larva, though minute and difficult to discover in the gall, is an exceedingly interesting form, since the appendages at the posterior extremity are evidently used as prehensile organs, as was demonstrated by observation upon living specimens last summer. The interior of the gall is so smooth that there would seem to be little or no opportunity for the larva to use this grasping power while in the deformity it produces, though it is possible that its ability in this direction may be extremely serviceable after the maggot enters the soil, which latter is presumably the case.

Larva. Length 1 mm., moderately stout, pale yellowish green. Head broad, broadly rounded anteriorly, almost subglobose. Antennae moderately long, stout, biarticulate, the basal segment disk-like, the apical one with a length over twice its diameter. Conspicuous brownish, presumably ocular spots may be observed near the latero-posterior angles of the head. Skin smooth, segmentation distinct; breastbone weakly chitinized, minute, reniform, the anterior margin with two small submedian teeth and more laterally a pair of smaller teeth; small scattering setae occur on the body; posterior extremity bilobed, the ventral portion bearing stout, submedian, chitinous, upcurved processes, each with an indistinct basal tooth anteriorly; the dorsal lobe broad, obliquely truncate as seen from the side and the face armed with an irregular series of moderately large, conical, chitinous teeth.

In life the hooks and this dorsal process are frequently apposed and evidently form an efficient grasping organ. The description was drafted from larvæ taken from the galls, the tips of which were turning brown, collected at Highland, N. Y., July 22, 1913. There were about seventy-five galls on one leaf.

E. P. Felt.

A DESTRUCTIVE PINE-MOTH INTRODUCED FROM EUROPE

(*Evetria buoliana* Schiffermiller)

By August Busck, *of Branch of Forest Insects, Bureau of Entomology, United States Department of Agriculture*

In May, this year, a correspondent from Long Island reported to the Division of Forest Insects of the United States Bureau of Entomology, that a Lepidopterous insect was seriously injuring some young Scotch pines (*Pinus sylvestris*), under his surveillance at Great Neck. Specimens of the larvæ and the injury were referred to the writer for identification.

The severity of the injury was at once realized, but the larva could not be identified. In order to ascertain the extent of the injury and to obtain sufficient live material for study and rearing, the writer was authorized to visit the locality and this was done on June 1. It was found that the trees had been planted on both sides of avenues, in a large, newly developed suburban tract, and that all of these trees were heavily infested by a Lepidopterous larva, which tunnelled the tips of the leading branches and thereby severely checked the growth and injured the appearance of the trees. On some of the young trees, eight to ten feet high, as many as fifty terminal shoots had been destroyed and their usefulness as ornamental trees was much impaired.

At this time many of the larvæ had pupated and from the material secured a large number of the moths issued during the last half of June at the field station for forest insects, East Falls Church, Va. It proved to be the well-known European *Evetria buoliana* Schiffermiller, which has hitherto not been reported from this country.

This species, which also occurs in Siberia, does considerable damage to the pines of Europe, and it has been the object of much study and an extensive literature. It is generally recognized by leading foresters in Europe as one of the most or even the one most injurious insect to *Pinus sylvestris* and other pines. A characteristic result of the injury of this insect is a peculiar curved growth, the so-called "Posthörner," "Baionnette," which is a familiar sight in European pine forests, and which seriously depreciates the value of the trees.

The occurrence of this insect on Long Island is, therefore, of some importance; our several indigenous *Evetria* species already constitute a serious problem, especially in the culture of young pine trees, and this European importation may well outrank our native species in destructiveness. However, it is futile to speculate about the possible spread of the species to our native pines and the resulting injury, but it is, at least, a just cause for apprehension and it should be care-

fully watched in view of the experience with other forest *Lepidoptera* introduced accidentally from Europe.

How long the species has existed in this country and how extensive is its present range must be determined by investigation. It was observed on the pines at Great Neck last season also, 1913, and Dr. Hopkins was informed about it, but too late to secure material.

However, it seems probable that it is a recent introduction, considering that the species has not been noticed before, although special work on this group of pine insects has been done by Packard, Riley, Fernald and later workers, and extensive and careful collecting has been done in recent years on Long Island by the several active entomologists of the vicinity, and the more so, as it is a strikingly colored, orange-red insect, three fourths of an inch or more in alar expanse, larger and quite different from the other species of the genus. The work also is easily noticeable and presumably would have been observed before, if the species had been present.

The eggs are laid on the buds of pine in the late summer; the young larva eats out one bud during the fall and overwinters within; in the spring it leaves this bud and attacks the young growing buds, excavating and successfully killing a number of these; as the twigs grow, the larva often eats only one side of them, thereby causing the above-mentioned curved growth, which results in the characteristic "Post-horn." The larva is dark brown with black head and thoracic shield, it becomes mature early in June and pupates within the last silk-lined burrow; the moth is 17–22 mm. in alar expanse; the forewings are ferruginous orange, suffused with dark red, especially toward apex, and with several irregular, anastomosing, silvery cross-lines and costal strigulæ.

The species has only one generation in Europe, overwintering as half-grown larvæ and issuing as moths in July, but allied species of the genus in this country have two generations annually, and it is not impossible that *Evetria buoliana* may also develop two broods in this climate and thus greatly increase the potentiality for injury.

Entomologists and others interested are asked to be on the lookout for this destructive insect and to please report eventual outbreaks to Dr. A. D. Hopkins, in charge of Forest Insect Investigations, Bureau of Entomology, United States Department of Agriculture.

EXPLANATION OF PLATE

Fig. 1. "Posthorn" growth caused by *Evetria buoliana.*

2. *Evetria buoliana* 2½ times enlarged.

3. *Evetria buoliana* young larva in pine buds.

1, after G. Severin: "*Le genre Retinia.*"

2 and 3, after J. E. V. Boas: "*Dansk Forstzoologi.*"

Proceedings of the Twelfth Annual Meeting of the American Association of Horticultural Inspectors

(*Continued*)

REPORT OF COMMITTEE ON STANDARDIZATION OF PHRASEOLOGY AND VALUE OF INSPECTION CERTIFICATES

The undersigned committee begs to submit the following report:

It has long been recognized among state inspection officials that there is a diversity of wording, meaning and value of inspection certificates which is not only confusing and misleading but which conflicts with the general purposes of the inspector's work. In dealing with the subject assigned to this committee we must first of all clearly recognize the objects in view in state nursery inspections. This we believe is, beyond dispute, the restriction of the spread, the prevention of unnecessary dissemination, and the extermination whenever practicable of insect pests and plant diseases within the state maintaining the inspection service. In the prevention of unnecessary dissemination three lines for the accomplishment of good results are open. First, the management of local problems which are not of direct concern to other states; second, the prevention of nursery stock grown in the state being transported in interstate commerce in an infected or infested condition; third, the inspection of every living tree or plant imported into the state from another state. The last line of activity is not available to all state inspection officials at present. The second line is of immense importance to all states—even those fortunate enough to have provisions for the inspection of all imported trees and plants at destination. In order to receive the full benefits of efforts to prevent diseased and insect infested nursery stock being transported interstate, each inspection official must recognize this object as a purpose, in part, of nursery inspection work in his own state. The issuance of general nursery certificates or licenses with the knowledge that they will be or may be used as a required accompaniment of interstate shipments of nursery stock, is in itself a virtual recognition of this principle. A clear understanding by all concerned, of the phraseology and of the value of inspection certificates, will, we believe, lead indirectly to an improvement to a considerable extent in the condition of interstate shipments of nursery stock.

In acquiring information for the preparation of this report, a circular of questions was sent out to the head inspection official in each state and forty-five replies were received. The thanks of the committee are due these men for the full information and for many valuable suggestions which they have submitted.

Thirty-four state inspection officials report that they either have full authority to change the present wording of their state certificates or that it can be done without amendment of the existing law. Six only report legal limitations of any consequence.

Eighteen are in favor of retaining their present form of certificates only until something better can be decided upon; sixteen are unqualifiedly in favor of retaining the present wording; five are unqualifiedly opposed to retaining the present wording of their state certificates; three favor their present form with possibly

slight changes; one would "compromise for the sake of uniformity" although satisfied with his state certificate as at present used. Of the forty-three answering, twenty-four may be considered to have indicated a willingness to change the wording of their certificates to conform to any improvement which may be decided upon by this association, while nineteen may be considered not to have indicated such a willingness.

Twenty-five, or nearly 60 per cent of those answering the question, consider that their respective state certificates are literally accurate, twelve, or nearly 30 per cent, consider that their state certificates have a literal meaning but with miscellaneous mental reservations and qualifications, six do not consider their certificates to be accurately worded.

Thirty-six believe it practicable to secure uniformity to a reasonable degree at least; of the wording of certificates, three regard the accomplishment of this as doubtful, two regard it as impracticable and one expresses the conviction that uniformity of wording is unnecessary, that uniformity of *meaning* is all that should be desired. Of the thirty-six who replied in the affirmative, six expressed the following qualifications: (1) "If insects or diseases found were named in the certificate;" (2) "If every tree is inspected root and branch at the nursery;" (3) "By fumigating all stock not absolutely clean;" (4) "In simplified form;" (5) "Very liberal in form not too explicit;" (6) "One for the North and one for the South."

As far as can be determined, the inspection certificates of all states cover both insect pests and plant diseases except that in three cases "fungus" diseases only are specified in the certificates, omitting from consideration bacterial diseases, root knot and plant diseases due to unknown causes.

Thirty-five species of insect pests and twelve plant diseases necessitated the temporary withholding of inspection certificates in various states during the past year. Of these pests and diseases the San José scale is reported as the cause of the action named in 27 states, crown gall in 15 states, the oyster shell scale in 10, the woolly apple aphis in 9, pear blight in 7 states, the scurfy scale in 5 states, the peach borer in 5 states, and all of the other pests and diseases in less than 5 states each. In the foregoing enumeration several states have been included more than once.

Of 41 states answering the question concerning the matter, 34, or nearly 85 per cent, have only one form of certificate which is used on stock which is grown in nurseries where no pests whatever are found and also in nurseries where pests were found, but subsequently apparently exterminated. Of these 34, six provide for the inspection of the stock at the nursery at the time it is dug and under such a provision the certificate has an entirely different meaning and value. One state reports one form of certificate with a few special exceptions, and six report different kinds of certificates adapted to the circumstances. Florida has five types of certificates. In addition to the ordinary blanket certificate and special package certificates, a local sales certificate is used. This is issued to nurseries having stock diseased or infested by pests in any degree and located in sections where those particular diseases or pests are prevalent. They are plainly indicated as void for rail or water shipments. Kansas and New Hampshire issue two kinds of certificates, one the ordinary blanket form and one a certificate of fumigation. Ohio also issues these two forms but, in addition, has strict requirements concerning the disposition of the stock fumigated for the San José scale, not permitting it to be sold in the state except in infested sections and with the knowledge of the purchaser. In Louisiana certificates are issued which are limited to use for certain

plants only. In West Virginia two forms of certificates are issued covering two classes of nurseries, one where no "dangerously injurious insects or plant diseases" are found, and one where such have been found and subsequently exterminated.

Of 43 states furnishing the information 26 have no established list of named pests to which their certificates have special application. Seventeen states have a regular list. The inclusion in the state law of such phrases as "San José scale and other injurious insect pests or plant diseases" is not here regarded as an established list. Of the established lists, the most comprehensive is that of Connecticut which includes 20 insect pests and 10 plant diseases, closely followed by Utah with 17 insect pests and 11 plant diseases. In many cases the list is more or less elastic, but in several states, even with comparatively limited lists, insect pests and plant diseases not officially designated as "dangerous" are disregarded. In the case of two adjoining states having practically identical insect pest and plant disease problems, one disregards all except 11 insects and 7 plant diseases, total 18, while the other practically disregards all except six insects and three plant diseases, total 9. In another instance all except 16 insect pests and plant diseases are disregarded while in an adjoining state all except 10 are disregarded.

With reference to the insects which are regarded as "dangerous" pests, the reports from several states inform us that certain economic insects, such as the oyster shell and scurfy scales are regarded as coming within the meaning of the state law or certificate only when they are doing actual damage to the nursery trees where found. This practice may be objected to on the ground that a badly infested tree is more likely to be noticed by the average purchaser or even culled out by the nurseryman himself, whereas the slight infestations are more apt to be overlooked and are therefore more likely to be the cause of transferring insect pests to previously uninfested orchards or localities.

Reporting on crown gall, which disease was taken as an example to determine the difference in values and meanings of certificates, 37 inspection officials require the destruction of infected stock or at least do not permit its sale. Of these 37, six provide inspectors to examine the stock when dug and to see that the requirement is met, three require a written pledge from the nurseryman that infected stock will be separated out and destroyed and 28 apparently have no formal arrangements concerning the matter. Aside from the 37 who report *requirements*, two report that the nurserymen are "requested" to separate out and to destroy the infected stock, two report no requirements and two are fortunate in not having met with the disease in their respective states.

Answering a question as to whether it would be practicable to file annually with every other state inspection official, a list of nurseries to which certificates have been issued, thirty-seven states report in the affirmative, one can furnish list of bonded and licensed nurserymen, two report lack of provisions for the extra office work and for postage and two report that no general certificates are issued. These two could no doubt furnish lists of bonded or licensed nurserymen.

One question related to the practicability of each state inspection official in charge furnishing each other chief state official with a detailed report of the exact findings of the inspectors in each nursery. Thirty-three, or more than 75 per cent, gave not unfavorable replies, including 31 affirmative replies without qualifications. Two considered the matter doubtful. Six, including one on account of lack of funds, reported unfavorably, while two could not coöperate since no general certificates were issued.

The examination of the general inspection certificates of 30 states shows con-

siderable variation in the phraseology concerning the pests and diseases. Nine specifically mention the San José scale. The general terms used are as follows:

''dangerously injurious insect pests and plant diseases,'' 11 states; ''injurious insects and plant diseases,'' 4 states; ''insects and diseases of a seriously dangerous nature,'' 2 states; ''any contagious or infectious disease or the San José scale or other dangerously injurious insect,'' 2 states; ''dangerous insects or plant diseases,'' 1 state; ''insect pests and fungus diseases,'' 1 state; ''destructively injurious insect and fungus enemies,'' 1 state; ''destructively injurious pests,'' 1 state; ''dangerous insects and dangerously contagious tree and plant diseases,'' 1 state; ''dangerously injurious insects and contagious plant diseases,'' 1 state; ''disease, scale or other dangerously injurious insects,'' 1 state; ''dangerously injurious pests or fungus diseases,'' 1 state; ''dangerously injurious insect pests or dangerously destructive plant diseases,'' 1 state; ''dangerous insect pests and dangerously contagious tree or plant diseases,'' 1 state and finally ''noxious or injurious diseases likely to be transmitted on nursery stock,'' 1 state.

It appears evident that these variously phrased certificates are all intended to have about the same meaning and that they do in fact have identical meaning to the general public. The advertising values to the nurseryman are the same even though a scientific man may recognize the fact that ''crown gall'' and pear blight are not included as ''fungus'' diseases and that a certificate regarding crown gall issued without an examination of the roots is valueless. It has been shown by the replies which have been classified in this report that the general designation ''dangerously injurious insect pests and plant diseases'' or the equivalent can be interpreted only by one who knows which, if any, pests are listed and which disregarded in the states maintaining an established list, and in the other states which pests are personally regarded as dangerously destructive by the official in charge. The reports from many if not most states, plainly indicate that the interpretation to be given to the certificate phraseology applies strictly within the limits of the home state.

Certain variations from the ordinary systems of certification have been mentioned. Other noteworthy variations are the systems in Arkansas, Illinois and Wisconsin. The first two states issue certificates which are given more than ordinary value by a system of signed agreements relating to the treatment or the elimination of stock infested or infected with woolly apple aphis, crown gall, peach borer and other common pests found in the nursery in nearly all sections of the country. Following a report on the condition of the nursery and specifications as to required treatments, the Illinois system requires the nurseryman to sign the following agreement as a condition of the issuance of the certificates.

''I ———————— hereby promise and agree that the above mentioned conditions shall be observed as affecting any and all nursery stock grown or growing on my premises; and I also agree that I will not use, or permit to be used, any official certificate of nursery inspection issued to me by the Illinois State Entomologist on any of the stock to which the above prescriptions and requirements apply, until said prescriptions and requirements have been fully complied with.''

Signature ————————.

Date ——————.

The Wisconsin system is one of permits rather than of ordinary inspection certification. No declaration is made as to the apparent freedom of the stock from pests, but we believe no one can question that such permits mean fully as

much as those which are specific and comprehensive in their declarations and, furthermore, are above criticism on the charge of misrepresentation in any respect.

The following noteworthy suggestions have been received by the committee in connection with the question sheets sent out for information:

Mr. H. M. Williamson, secretary of the State Board of Horticulture of Oregon, recommends as a solution of the problems concerning interstate shipments of plants, that all such shipments should be inspected by agents of the Federal Government. Dr. E. W. Berger of Florida suggests that the Federal Horticultural Board be given power to regulate interstate shipments of plants, especially with the view to providing for complete information concerning the pests found in each nursery making interstate shipments, such information to be placed in the hands of the inspection official in charge in each state. Professor Summers of Iowa and Professor O'Kane of New Hampshire express the sentiment that the matter of uniformity of wording is of comparative little importance, that it is the standardization of meaning and of value which is needed. Professor Sanders of Wisconsin recommends the license system used in his state as of value incidentally in eliminating dishonest dealers and he recommends the plan of including the acreage in each case as a part of the license, stating that this prevents much misrepresentation. The inspection officials of Montana, Idaho, Maryland and Arizona endorse the plan of inspecting everything at the time the stock is dug or packed for shipment. Professor Symons of Maryland calls attention to the fact that San José scale is not nearly as bad a pest from the average commercial orchardist's standpoint as is crown gall, yet the former is much more carefully guarded against by our state inspection work. Professor Haseman of Missouri suggests that each state inspector draw up a list of insects "which he considers of sufficient importance in his particular state to justify the quarantining of nursery stock infested with them," such lists to be published, or exchanged with other state inspectors.

The following states inspect incoming shipments of nursery stock after their arrival in the state:—Arizona, California, Colorado, Massachusetts, Montana, Idaho, New York, Oregon, Washington, Utah and Texas. In this connection the following comments by Mr. T. O. Morrison, deputy commissioner of Horticulture in Oregon are of interest: "I would like to see a uniform method or system of inspecting nursery trees throughout the United States. Many of the shipments that come to our state bearing a printed certificate of inspection from a state entomologist in the Middle West or East show that the stock of a nursery consisting of several hundreds of acres was inspected on a certain day in August, etc. Such a certificate is absolutely worthless and moreover is misleading. We accept such a certificate as meaning that the inspector casually walked through such and such a nursery on a summer day. I say this because we find any amount of infection under such a certificate. A uniform system of inspection it seems would make the inspection certificate of more dependable value."

After careful consideration of the large amount of information and suggestions furnished by the state inspection officials and of the available information and data in published reports concerning the inspection of nursery stock shipments at destination, all bearing upon the actual value of inspection certificates, we beg to offer the following recommendations:

1. We recommend that the section of Horticultural Inspectors officially endorse the system of each state providing for the inspection of all nursery stock shipments from the states after its arrival within the state to which it is consigned.

2. Since it will undoubtedly be many years before such a system will be adopted

by even a majority of the states, notwithstanding its desirability, we recommend, as a much needed reform of nursery inspection practices, the abandonment as soon as possible, of those features of nursery certification which are self-condemned by the assembling of the facts as presented in this report.

3. We recommend more especially against the use of words in the certificates which necessitate mental reservations of any kind; if a limited number of pests are exclusively referred to by the inspector, such lists should accompany each certificate as a part thereof; if such pests as may be considered as dangerously injurious in the state without regard for outside sections are exclusively referred to by the certificate, such should be plainly indicated in the certificate.

4. We recommend that where local conditions require a special form of certificate for the sale and shipment of nursery stock wholly within the state, full consideration be given to a wording and style of certificate appropriate for the interstate shipments. In this connection we call attention especially to the styles of certificates now in use in Florida.

5. We recommend that insect pests and diseases which affect the roots of nursery stock and which cannot be observed by the inspector until the trees are dug, be plainly omitted from the certification, except where tree by tree inspections are made after the trees are removed from the ground.

6. We recommend that where lack of sufficient financial support prevents thorough inspection of the roots of nursery stock after the trees are dug, that such certificates or licenses as are provided the nurserymen be granted under strict written agreements concerning the separation and destruction of diseased or insect-infested trees at the time the trees are removed from the nursery rows. We call attention here to the system used in Illinois and in Arkansas.

7. We recommend as a condition for the issuance of a certificate covering nursery stock standing in the nursery, that the owner of the trees agree to eliminate as far as possible all crown-gall-infected trees and all stone-fruit trees infested or injured by peach borer and trees of any kind infested with nematodes, and that the shipments upon which certificates are used be guaranteed to be free from visible infection or infestation to the extent of 95 per cent.

8. We recommend for the consideration of this section the following form of certificate as the basis for the adoption of a uniformly phrased general certificate covering interstate shipments:

This is to certify that the nursery stock of ———————— consisting of ———— acres located at ———————— has been inspected by the undersigned or his representative, that the said ———————— has agreed to comply with regular requirements for the elimination of infested or diseased trees or plants as a condition of the issuance of this certificate, and is hereby authorized to use this certificate or a copy thereof on interstate shipments of the stock specified until ———————— unless revoked for cause. It is further understood and agreed that neither this certificate nor a copy thereof shall be used to attach to a package or parcel of trees or other living plants to be shipped by mail into states where provisions have been made for the inspection of imported trees or plants at destination.

Signed ————————.

I hereby certify that all provisions have been agreed to and the terms complied with in every detail.

Signed ————————.

9. We recommend that the foregoing information furnished by the various inspection officials and our recommendations be printed and placed before the members of this section for final action at the next annual meeting of this section, and that in the meantime each official endeavor to remove objectionable features from his certificates.

Respectfully submitted,

A. W. Morrill,
Franklin Sherman, Jr.,
F. L. Washburn,
Committee.

Megilla Maculata. While cutting a large chestnut tree, April 20, in an obscure cavity, partially filled with leaf mould and in which there was still some frost, there was found a ball or cluster of *Megilla maculata*, De G. The numbers exceeded sixty, but probably not one hundred and ten. I personally counted fifty-eight and saw other scattered specimens. They were lively although somewhat cold. Among them was one specimen of *Adalia bipunctata* L. This hibernating cluster also showed some mortality which apparently is significant. In one spot, adhering to a bit of punky wood, were three dead *Megilla maculata* De G. Furthermore, they showed some signs of mould. This may be secondary and not a feature of their death. It could not be said definitely that the hibernation occurred within the leaf mould, although apparently the insects had buried themselves.

Burton N. Gates.

A New South American Scientific Journal. Prof. Charles E. Porter, occupying the chair of general zoölogy and applied entomology and also director of the recently established Museum and Laboratory of Economic Zoölogy at the National Agricultural Institute of Santiago, Chili, has undertaken the publication of a new scientific journal under the title "Anales de Zoölogia Aplicada." This journal is to be especially devoted to original studies on species beneficial to and parasitic on man, domesticated animals and cultivated plants in America. The well known "Revista Chilena de Historia Natural," edited by Professor Porter, is being continued, but only for systematic papers. The "Anales de Zoölogia Aplicada" will be published quarterly, in 8°, on excellent paper, profusely illustrated with text figures and when necessary with plain or colored plates. Original contributions on American parasites (Protozoa, Vermes, Arthropoda), in English, French or Spanish will be accepted. Announcements of books, other scientific periodicals and instruments relating to the subject matter of the journal will be printed on colored special pages. The director wishes to exchange the "Anales de Zoölogia Aplicada" with all special journals of economic zoölogy and entomology. The subscription price is 25 francs a year. Advertisements on colored pages 25 francs per page for each number. The address of the director of the new journal is: Prof. C. E. Porter, C. M. Z. S., F. E. S., Director de los Anales Zoölogia Aplicada, Casilla 2974, Santiago, Chile.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

AUGUST, 1914

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—Eds.

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There have been marked advances in the uses of insecticides in recent years and it is a pleasure to include in this number an article relating to soil fumigation. This is a difficult problem and one worthy of careful study. Enough progress has been made to suggest the possibility of a practical soil fumigant being developed for the control of subterranean pests of staple crops. It might be feasible to use such materials in connection with fall plowing, if land could not be safely planted within a few weeks after treatment. This is one of the weak points in entomological practice. It is to be hoped that the inherent difficulties will be overcome soon and a generally available soil fumigant found.

The interdependence of entomologists as well as the value of our insecticide batteries was shown by the developments of the last few weeks in New York state. A localized though widespread outbreak of the redlegged grasshopper and several associated forms was quickly handled in threatened grain fields by the use of the Kansas bait, brought to notice only last year. Dying insects were to be seen within four hours after the distribution of the bait and within three days about four-fifths of the grasshoppers in a field were dead. Our eastern grasshoppers are rarely migratory and consequently there was not the need of general coöperation among farmers in the infested area as in Kansas, though united action is desirable and increases the value of the measures adopted.

Reviews

Traite D'Entomologie Forestiere, by A. BARBEY. Berger-Levrault, Paris, France, 1913.

This volume, intended for foresters and woodland owners, contains brief chapters on insect anatomy and insect classification, then discusses the principal insect pests of each kind of tree used in forest planting, beginning with the conifers. Under each host tree the insects are treated as follows: attacking the roots; bark of the trunk and branches; interior of the wood; branches; buds, and leaves.

The book contains 624 pages, 367 text figures, 8 colored plates, and a bibliography of 94 references to European literature. Many of the text figures are from excellent photographs and the plates are from drawings.

Though this volume is not indispensable to the forest entomologist in America, it is useful as a reference work, and therefore finds a place in department libraries. Those engaged in the inspection of imported nursery stock, and those studying European pests liable to be brought into this country, will find this book useful, and perhaps therein lies its greatest value to American entomologists.

W. E. B.

Die Forstinsekten Mitteleuropas. Ein Lehr- und Handbuch by K. ESCHERICH. A new edition of Judeich-Nitsche, text-book of central European forest entomology. Revised. Vol. I. General Introduction to the structure and life habits of insects, as well as the general fundamental principles of practical forest entomology. 6°, 433 pp., 248 text figures. Berlin, 1914.

Although this volume appeared only this year it has quite an interesting history. In 1841 Ratzeburg, the father of forest entomology in Germany, published especially for private libraries and foresters a small volume entitled "Die Waldverderber und ihre Feinde." So great was the demand for it, that in 1869 he issued a sixth edition. Each of the editions was revised and enriched with fresh observations. A seventh revised edition was issued by Judeich in 1876. In 1885, Judeich & Nitsche published the first part of a completely revised and enlarged edition under the new title as above, though still designated "the eighth edition of Ratzeburg's" original work. It will be noted that in the present volume Ratzeburg's name is absent from the title page.

Says the author in the preface: "About thirty years have now elapsed since the first part of 'Judeich-Nitsche' appeared—thirty years full of activity and endeavor in our science. Everywhere, primarily in North America, as a result of the recognition of the profound significance of insects on life under our cultivation, applied entomology has been studied with a hitherto unknown zeal and scientific earnestness. An enormous amount of new facts of general importance were thus brought to light and some of the earlier views must either be more or less modified or entirely thrown overboard, so that our science today presents an essentially different aspect and also places higher requirements upon the knowledge and skill of its representatives than the science of thirty years ago."

Four volumes are contemplated, of which this is the first. This is more than twice as large as the corresponding part of the old edition, made necessary by the comprehensive treatment of the anatomy, physiology and developmental history of the insects and especially by the exhaustive presentation of the factors limiting increase (Chapter VI) and the fundamental principles of effective rational control (VII). The last two subjects could not, in the author's opinion, "be treated with sufficient

thoroughness, as they represent the foundation of forest entomological practice. Whosoever has learned to think correctly on these points will remain warned against gross errors in practice."

The chapter on insect-killing fungi was prepared by Dr. G. Lakon, while the "Rules of Cultural Means of Prevention" come from Dr. W. Borgmann of Tharandt.

A bibliography is given at the end of each chapter, listing the most important pertinent works.

Special emphasis is laid on illustrations, of which the present volume contains much more than double the number of those in the corresponding part of the old edition. Only comparatively few of those in the old edition are here reproduced (indicated by N at end of legend). The new figures are partly borrowed from other works and partly original.

The volume before us is divided into eight chapters with the following chapter heads:

Chapter I. Position of Insects in the System.
Chapter II. External Appearance of Insects (Morphology).
Chapter III. Internal Structure of Insects (Anatomy and Physiology).
Chapter IV. Reproduction.
Chapter V. Insects as a Natural and Economic Power in General and especially in reference to Forestry.
Chapter VI. Natural Limitation of Insect Increase.
Chapter VII. Prevention and Control of Insect Calamities.
Chapter VIII. General Survey of the System of Insects with a supplement: Guide to the Establishment of a Forest Entomological Collection.

The Chapter on Insects as a Natural and Economic Power covers the subject from so many angles that it abounds in data of exceeding interest. After a brief discussion of the average size of insects, the number of genera and species, the masses of individuals and their distribution in the various media, the author classifies the directions in which the activity of insects is specially important as follows:

1. They hasten the disintegration of dead organisms.
2. They destroy numerous living organisms and thus contribute to the maintenance of the organic balance;
3. They constitute the necessary source of food of many other animals;
4. They bring about cross fertilization of many plants;
5. They assist in the distribution of the plant world, and
6. They participate in soil building.

Of these, 1, 3, and 4 were discussed by the original authors (Judeich & Nitsche), 2, 5, and 6 being new additions. Of these, the last two are of interest, primarily because based on most recent studies.

In his discussion of the "*Degree of Destructiveness of Forest Insects,*" the author enumerates the following influencing factors:

1. The biology of the given insect.
2. The tree species.
3. The age of the trees attacked.
4. The health condition of the plants.
5. The character of soil.
6. The weather conditions.
7. The season of the year in which the attack is made.
8. The sylvicultural conditions.
9. The geographical position.

Of these, the first one and the last two are not given, at least not in this connection, in Judeich and Nitsche. This is what the author has to say under caption 8 in its application to the United States:

"Difference of management has an important influence on the extent of injury. The degree to which this is true we can see from the fact, for instance, that in our clean kept forests under normal weather conditions, etc., the barkbeetles are scarcely a menace; while in North America, where forest management in our sense, to say nothing of a clean forest management, is scarcely known, they are responsible for the greatest devastations in the forests, and in many localities the very existence of the forests is jeopardized by them."

His discussion of "Cultural Methods of Prevention" Professor Borgmann concludes thus:

"If we review the various methods which are founded in the first place on the bases of *location* and *sylviculture* and, in the second, on *forest management* and *forest utilization* respectively, it is not difficult to recognize in the composite the fundamental principle of all preventive measures that *in a well ordered management, equally justified by the principles of a natural sylviculture as well as by economic requirements and free from a cut-and-dried one-sidedness, lies the best foundation for protection against great insect calamities.*"

This is what Professor Escherich has to say regarding our Gipsy Moth Campaign:

"Thus, the gigantic campaign which the Americans are leading against the gipsy moth represents a great step forwards also for German forest entomology; indeed, I may safely say, the most important progress that our science of forest entomology had to record in the last decade. It is therefore quite necessary that the German entomologist should be informed about it and that he draw the corresponding knowledge from it."

Like its forebears, this work promises to be a fairly complete compendium of a knowledge of forest entomology, especially as applied to cultivated forests. And yet, a careful perusal of the methods of prevention and control as given in the volume before us, particularly as to the details of the execution of the latter, thorough and comprehensive as they are from the viewpoint of forest conditions and practices in western Europe, as regards the United States one is led to the inevitable conclusion that not only the principal forest insect depredators but the very forest conditions in the United States are so radically different from those prevailing in Europe that, at least for the present, the practices prevailing there are applicable here only to a limited extent.

JACOB KOTINSKY.

May 26, 1914.

A Textbook of Medical Entomology by W. S. PATTON and F. W. CRAGG. Christian Literature Society for India, London, Madras and Calcutta, 1913, quarto) pp. i-xxxiv, 1–764, pls. LXXXIX.

This large volume covers a practically unoccupied field and relates to one of the most important phases of economic entomology. Within its covers we find a comprehensive and carefully prepared summary of what is known concerning pathogenic insects. The authors have been careful not to draw the lines too closely and still have some regard for space limitations. The book is designed particularly for medical workers in the tropics and is a "guide to a study of the relations between arthropods and disease." The information presented is conspicuous by its absence in most text and reference books on economic entomology and was of necessity gathered from numerous and widely scattered sources; in some instances little was available except that published by the earlier students of insect anatomy. The authors have been more concerned in elucidating, and rightly so in this instance, practical points of value to the experimenter and field worker, rather than the improvement of taxonomic

systems and the harmonizing of discordant elements in anatomical nomenclature important though the latter may be.

The first chapter outlines the history of entomology as a branch of preventive medicine, summarizes the classification of the arthropods and defines the principal life zones. The next two chapters, over 140 pages, discuss the external and internal anatomy respectively. The first is important as an aid to the identification of insects, while a knowledge of the internal anatomy, both macroscopic and microscopic, is a prerequisite for the satisfactory recognition of pathogenic conditions and the identification of the causative organism.

Certain pathogenic Diptera and their close allies, such as the Culicidæ, Tabanidæ, some Muscidæ, are discussed in detail. Members of the Siphonaptera, Rhynchota, Anopleura, Ixodidæ and Acari are similarly treated. The organism's relation to disease, its natural parasites, external anatomy, bionomics, methods of rearing in the laboratory, are some of the matters discussed. Each of the principal chapters concludes with a well-selected and classified biliography.

The investigator must first identify the insect. We have in this volume a number of keys from various sources for the recognition of species. These are supplemented by descriptions and numerous illustrations. Careful directions are given for the dissection of the various forms. The many practical hints for handling and rearing are invaluable and exceedingly suggestive. This work is a necessity to all students of the medical aspects of applied entomology, particularly in tropical and subtropical regions, while those in other sections will find much that is very serviceable. As a reference work, this publication should appeal strongly to the general economic entomologist and to all giving instruction of a collegiate grade.

Flies In Relation To Disease, Non-bloodsucking Flies, by G. S. Graham-Smith. Cambridge, The University Press, 1913, pp. i–xiv, 1–292, 24 pls. 32 text figs.

This is a critical and very conservative account of the part non-bloodsucking flies play in the dissemination of disease, as shown by available evidence. Furthermore, the author lays a substantial foundation for subsequent investigations. Chapters five and six, dealing with the structure of the proboscis and the functions of the anterior part of the digestive system, are particularly strong and worthy of careful study. They constitute a most fitting introduction to the chapters on habits, methods of observing flies in captivity, and the distribution of bacteria, all replete with significant facts and containing much of value respecting methods. The relation of flies to the more important diseases is illuminated with much original data and is considered without prejudice to the organisms under discussion, the author refusing to draw conclusions not amply supported by trustworthy evidence. He emphasizes the need of more epidemiological data before drawing general conclusions.

The entomologist, both economic and systematic, will be particularly interested in certain portions of the anatomical discussions, the evidence relating to the dissemination of disease and that in regard to myiasis. The physician and others with similar interests will find in this small volume an excellent summary and a practical introduction to a difficult and complex subject.

Current Notes

Conducted by the Associate Editor

Mr. J. R. Horton, of the Bureau of Entomology, recently visited Mobile, Alabama, to investigate the Argentine ant in its relation to citrus trees in that region.

Messrs. H. G. Barber, Charles W. Leng and F. B. Watson, of New York, will visit Porto Rico this summer to assist in the survey of the island, especially studying the insects.

Professor A. L. Melander, who has been on leave of absence studying at the Bussey Institution, Harvard University, for the past year, has returned to Pullman, Washington.

Professor A. B. Cordley, Dean of the Oregon School of Agriculture at Corvallis, and formerly entomologist, has recently been appointed Director of the Oregon Station.

Professor W. M. Wheeler of Harvard University is absent on a visit to Australia where he will attend the meetings of the British Association for the Advancement of Science, and collect and study the Australian species of ants.

Professor E. F. Hitchings, now associate professor of horticulture, University of Maine, formerly state entomologist, emerged about June 1 from five weeks in a Boston hospital and is recuperating during the summer at Enfield, Me.

Mr. F. L. Simanton has been placed in charge of the Bureau of Entomology laboratory at Winthrop, Me., to continue especially the codling moth investigations there undertaken last by Mr. E. H. Siegler.

Mr. John W. Bailey, a student of the Mississippi Agricultural College, who has been appointed temporary field assistant in the Bureau of Entomology, will be in charge of the work at Brownsville, Tex., in the absence of Mr. High.

Mr. M. E. MacGregor, a Carnegie scholar, has been engaged as a collaborator, Bureau of Entomology, in the investigation of the possible insect transmission of pellagra. He will be associated with Mr. A. H. Jennings at Spartanburg for several months.

Mr. R. H. Hutchison, of the Bureau of Entomology, has returned to Washington from New Orleans. He will be engaged on experiments with the house fly during the season. Mr. A. W. J. Pomeroy will be associated with him in this investigation.

Mr. C. H. T. Townsend, who has been director of the Entomological Experiment Station at Lima, Peru, returned to the United States July 1, and is now connected with the United States National Museum at Washington, where he should be addressed.

Mr. E. W. Geyer of the New Mexico Agricultural College, has been employed by the Bureau of Entomology to continue the codling moth investigations under way during the past two seasons in the Pecos Valley in New Mexico, and which were interrupted by the untimely death of Mr. A. G. Hammar.

Mr. J. S. Houser, of the Ohio Station, visited New Jersey, New York and the New England States early in June to study the methods employed in dealing with the gypsy and brown-tail moths and other shade tree insects. Mr. Houser visited several entomologists on this trip.

Mr. Loren B. Smith of Cornell University, formerly of the Nova Scotia Agricultural College, has been appointed Assistant State Entomologist of Virginia. Mr. Smith will be located at the Virginia Truck Experiment Station at Norfolk, and will take charge of the work on the truck crop insects.

Mr. T. E. Holloway, of the Bureau of Entomology, will spend several months in Europe during the summer, visiting Italy, France and Germany. He will be accompanied by Mr. G. N. Walcott of the Porto Rico Board of Agriculture.

Mr. F. M. Wadley, a student of the Kansas State Agricultural College, is assigned as temporary field assistant in the Bureau of Entomology to coöperate with Mr. F. B. Milliken at Garden City, Kansas, in work on truck crop insects, especially on insects injurious to sugar beets.

Mr. Mason, a Carnegie scholar, who has been in this country for about a year, recently having studied at Cornell University, has been appointed Government Entomologist in Nyasaland. He spent some days in Washington during the month preparatory to leaving for his new post.

Hearings were held by the Federal Horticultural Board, on May 15, regarding the pink boll worm which occasionally comes into this country in cottonseed in bales of lint; on June 22, regarding the extension of the quarantine against the gypsy and brown-tail moths in the New England States.

Mr. John A. Grossbeck, a specialist in geometridæ, and for the last few years connected with the American Museum of Natural History in New York, formerly assistant to Dr. J. B. Smith at the New Jersey Station, died in Barbadoes, British W. I., April 8, 1914. Mr. Grossbeck was born in Paterson, N. J., February 2, 1883.

Mr. Jacob Kotinsky, who was formerly Entomologist of Hawaii, had been appointed entomological assistant in the United States Bureau of Entomology and assigned to the Division of Forest Insect Investigations of which Dr. A. D. Hopkins is in charge. Mr. Kotinsky's present address is Silver Spring, Md., R. R. No. 3.

Mr. M. M. High, entomological assistant, Bureau of Entomology, who has been working on truck-crop and stored-product insect investigations, especially on onion pests, at Brownsville, Tex., will resume his midsummer headquarters at Knox, Ind., where he will continue on the same class of insects under different climatic and soil conditions.

Mr. E. A. Miller, graduate 1908 of the Texas A. and M. College, who has been Plant Pathologist and Assistant Entomologist for the past two years, has taken up work with the L. & N. Ry., in the capacity of horticulturist, plant pathologist and entomologist. Mr. Ed. L. Ayers, B.S., 1914, of the A. and M. College has been appointed to fill Mr. Miller's place in the Texas Department of Agriculture.

Mr. E. J. Newcomer, of Leland Stanford University, has been employed by the Bureau of Entomology and assigned to work on deciduous fruit insects in the Wenatchee Valley, Washington. In coöperation with Mr. D. F. Fisher, representing the

Bureau of Plant Industry, a special investigation is being made of Stigmonose of the apple.

Mr. Boyd L. Boyden, scientific assistant in the Bureau of Entomology, who was formerly employed at Whittier, Cal., where he was associated with Messrs. R. S. Woglum and John E. Graf, recently coöperating with the latter in work on wireworms affecting sugar-beet and other crops, will take headquarters at Oxnard, Cal., to continue investigations on sugar-beet and bean insects.

Owing to injury to citrus trees in California by the citrus mealy bug and allied species, it is proposed to establish a field station of the Bureau of Entomology to investigate these pests and devise means for controlling them. This work will be in charge of Mr. R. S. Woglum, and when he has found a suitable location for the new station, the one at Whittier will be discontinued.

Mr. Arthur H. Rosenfeld, director and entomologist of the Tucuman Argentinal Agricultural Experiment Station and a foreign member of the American Association of Economic Entomologists, was named Professor of Entomology in the University of Tucuman by government decree last April. Mr. Rosenfeld was also made a Fellow of the American Association for the Advancement of Science at its Atlanta meeting.

At a recent meeting of the board of trustees, Maryland Agricultural College, Professor T. B. Symons, State Entomologist and dean of the School of Horticulture, was appointed director of the Extension Division which has recently been formed at the Institution. Professor Symons will, however, continue to direct the entomological work in the state. Mr. E. N. Cory, associate professor at the same Institution was promoted to Professor of Zoölogy.

In the Division of Apiculture, Bureau of Entomology, Dr. N. E. McIndoo went to Winchester, Va., to coöperate with Mr. E. B. Blakeslee of the Deciduous Fruit Insect Investigations, in a study of the effects on honey bees of spraying fruit trees while in full bloom. To obtain further data he will go to Winthrop, Me., to the branch laboratory under the direction of Mr. F. L. Simanton, about June 1. Dr. G. F. White, who spent the winter in Ithaca, N. Y., has returned to Washington. Mr. George S. Demuth closed up the work on the wintering of bees in Philadelphia about the end of May.

In response to a demand from grape growers in the Lake Erie Valley, a laboratory has been re-established by the Bureau of Entomology, at North East, Pa., where further investigations of grape insects and other deciduous fruit insects in general will be made. Especial attention will be given to the grape berry moth, which still continues to be a grape pest of first importance in that general region. Mr. Dwight Isely, of Cornell University, has been employed to look after the general biologic and field work, and Mr. R. A. Cushman has been transferred from the Vienna, Va., laboratory to North East, Pa., and will have charge of the investigations of parasites of the grape berry moth, to which it is proposed to give more attention than has been possible heretofore. Mr. Cushman will also make a study of the apple-seed Chalcis, which, in recent years, has been the cause of considerable complaint from apple growers.

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(*Continued*)

PROGRESS OF VERRUGA WORK WITH PHLEBOTOMUS VERRUCARUM T.

By CHARLES H. T. TOWNSEND, *Director of Entomological Stations, Lima, Peru*

The following is a brief abstract of the results to date from inoculations of laboratory animals with *Phlebotomus verrucarum* T. at the Verruga Laboratory in Chosica (near Lima), Peru. The temperatures given are all rectal and Centigrade. All weights are in grams. All dates are 1913.

It may be said by way of preface that Dr. R. P. Strong, of Harvard, assisted by others, has recently put forth the opinion that Barton's *x*-bodies are the causative organism of Oroya fever, and has bestowed on them the name *Bartonia bacilliformis*; that verruga eruption is caused by a virus present in the eruption; and that the two are separate pathologic entities. To this the writer of the present article does not agree; but the *x*-bodies in question, or what appear indistinguishable therefrom morphologically, are referred to herein as Bartonia bodies.

It is well to state that the Verruga Laboratory at Chosica is quite outside the limits of the verruga zones, the nearest known verruga locality being Santa Eulalia some three miles distant. The topography of the country lying between Santa Eulalia and Chosica, the unfailing strong winds in the Chosica valley, the heavy night fogs during the cool season, and the lack of sufficient rainfall during the warm season, all combine to preclude any chance of the disease reach-

ing Chosica, since these conditions are inimical to the establishment and persistence of the Phlebotomus in the vicinity.

Santa Eulalia, about 3,500 feet, marks the lower limits of the verruga zone of the Rimac valley, and Matucana, about 7,800 feet, marks its upper limits. The Phlebotomus has been found by the writer at both places, and at several intermediate points. It is most abundant at Verrugas Canyon, about 5,300 feet, being abroad there every night in the year. Practically all the Phlebotomus used in these experiments were brought from Verrugas Canyon.

Experiment I

Cebus capuchinus, male, 2 or 3 years old, from Peruvian montanya. Average temperature under 39°. Kept in laboratory from April 22 to October 10. Perfectly normal and healthy, blood normal. On October 10 he was taken to Verrugas Canyon and chained to a tree at east end of house next to stone wall from which issue the Phlebotomus in large numbers every night, and kept there continuously till November 6, when he was returned to the laboratory in Chosica. On many nights spent in Verrugas Canyon by the writer and his assistants, from July 9 to November 6, not a single bloodsucker of any description was seen flying other than the Phlebotomus, and the writer has personally spent the entire night in such search. It is thus quite certain that this monkey was not bitten by any culicid or other night-flying bloodsucker in addition to the Phlebotomus. Blood smear taken October 15 showed nothing. Smears taken November 12 and 18 showed Bartonia bodies in small number. Temperatures varied from 39.3° to over 43°, but no high temperature was long continued. Miliar eruption began to appear on orbits November 13, decreasing on November 17. Miliar sore appeared on back of left hand November 18, and one on outside of left foot at ankle. November 21 showed five bleeding miliar sores, being on left orbit, left hand, left elbow, and both feet, all having scabbed over the following day. For several days these were most typical, with exudation, exactly like miliar eruptive sores commonly seen on legs of human cases. The left orbit, left hand and elbow sores practically dried up November 28, the feet still remaining scabbed for some time thereafter. Later about five sores developed on the back and continued for over three weeks. This was evidently the acute type with miliar eruption.

Experiment II

Cebus capuchinus, male, about two years, from Peruvian montanya. Admitted to laboratory April 22 with the preceding. Average temperature under 39°. Normal weight about 4,500. Perfectly sound

and blood normal. Injected subcutaneously September 4 with 75 Phlebotomus in physiological solution. Marked leucocytosis shown in smears of September 5 to 7 inclusive, especially latter date, white cells becoming normal on September 8. Smears of September 6 and 7 show Bartonia bodies. September 5 to 8 the temperatures varied from 39.2° to 40.2° on latter date, and averaged .7° above normal for two weeks thereafter. September 6 the animal weighed only 3,900, was decidedly ill, thin, with no appetite. Weight gradually increased after that date, appetite improving on following days. No visible external sign of eruption has appeared. This seems a case of cutting short the disease by phagocytosis, at least to an extent, in an animal not particularly susceptible but rather resistant.

Experiment VI

Lepus cuniculus, male, about 1 year, brought to laboratory March 29 from Jauja, 11,000 feet. Temperature average under 39°. Normal weight 1,700. Healthy, blood normal. Kept in cage August 7 to 11 with nine living Phlebotomus, most of which died on second and third days. Injected subcutaneously August 8 with 21 Phlebotomus in physiological solution. August 9 to 14 temperatures varied from 38.4° to 39.5°, weights falling to 1,588 on latter date. Smear of August 11 shows Bartonia bodies and marked leucocytosis which continued till August 13, leucocytes becoming normal the next day. August 16 smear also shows Bartonia bodies, but white cells were normal. Temperature was below normal on that date, after which weights and temperatures approximated normal and no visible external eruption appeared. On October 16 the animal received a scrotal injection of a small quantity of virus from nodular verruga eruption of man. The result of latter inoculation was a small scabbed verruga at point of injection, persisting from November 4 to 26. This appears to be a case somewhat similar to No. II, the verruga organisms being largely phagocyted out of the system following the infection with Phlebotomus. That such course does not confer immunity is indicated by the localized verruga following the inoculation two months later with virus from man.

Experiment XV

Canis caraibicus, female, about 18 months, from Chosica. Admitted to laboratory April 24. Average temperature under 38.5°. Normal weight about 3,500. Perfectly sound, blood normal. Injected subcutaneously July 11 with 20 Phlebotomus in physiological solution. The course of this case up to July 19 is published in the *Journal of the American Medical Association* (Nov. 8, 1913). Nodular eruption on

feet appeared July 17, the animal having been decidedly ill the day before and showing Bartonia bodies in the blood. Temperatures did not rise appreciably, being less than a degree above normal average. Weights slightly lowered. Papules on feet receded and renewed, sometimes bleeding, up to August 29, when weight fell to 2,957 and eruption distinctly decreased in intensity, remaining so for some days. September 4 the extreme tips of both ear-lobes showed eruption, scabbed, bleeding more or less, of the excrescentic-nodular type, continuing on both ears till September 29, and on right ear till October 16 when it had nearly disappeared. Sections of ear tips and papules show portions with apparent histology of verruga eruption. On October 16 this dog received five separate subcutaneous injections, in distinct regions, of virus from nodular verrugas of man. Absolutely no result followed these five inoculations, no lesions forming at points of injection. This indicates immunity conferred by the Phlebotomus injection of July 11 followed by a generalized eruption. It is quite possible that internal eruption may also have ensued, as indicated by continued loss of weight and more or less pain in joints and body.

Experiment XVI

Canis caraibicus, male, about 2 years, from Chosica. Admitted to laboratory April 24. Average temperature under 38.5°. Normal weight about 6,300. Sound, blood normal. This animal received five separate subcutaneous injections on September 19, 23, 25, 27, and October 12, with 80, 75, 107, 109 and 50 Phlebotomus respectively in physiological solution, the injections alternating between the two shoulders. Smears showed Bartonia bodies September 20 (22½ hours after first injection), September 25, and again October 14. They showed leucocytosis beginning September 27 and 28, increased September 29 and 30, white cells normal again October 1 and continuing so until October 13, when another increase was noted, which had disappeared next day. Polychromatophilia of the erythrocytes was evident September 21 to 25. Temperatures ran 37.7° to 40.6° from September 20 to October 7, but only rarely fell below 39° and were nearly always close to 40°. October 7 to 12 temperatures decreased some, going below normal on latter date and remaining so continuously till November 2, except only October 20 and 27. Weights gradually dropped to 5,808 September 28, with temperature of 40°, and remained under 6,000 to September 30 inclusive. Abscesses of considerable size formed at points of the five injections, but all were absorbed except the fifth which broke October 18. November 2 a nodular verruga suddenly formed on dorsa median line between shoulders, and increased in size during next two days, being of large size

with angular scabs on November 4 when it was excised. Another verruga at once began to form in its place, reaching good size November 10 and continuing with slight further growth to December 15 and later. A small typical nodular verruga formed November 20 to 22 on base of an ordinary wart which had sloughed on former date. This was on right chest and the verruga was excised November 22. Sections of these two excised verrugas show the identical histological structure of nodular verrugas from man. To sum up, this dog has shown decrease in weight, marked rise and fall of temperature, Bartonia bodies in blood, with spare leucocytosis and erythrocytic polychromatophilia, followed by what must be considered a generalized though meager eruption, as result of injection of over 400 Phlebotomus from Verrugas Canyon. Internal eruption may also have ensued in this case. This is the star injection experiment, and the one which has afforded the most convincing results.

Experiment XIX

Cavia cobaya, male, born in laboratory May 13 of parents from Jauja. Average temperature 38.5°. Average weight about 400. Perfectly healthy and blood normal. Placed in cage July 29 with two living Phlebotomus, to which were added six from Matucana on August 2, being removed finally from cage August 7 on death of the last Phlebotomus. Smears of August 7 and 16 show Bartonia bodies. A marked lymphocytosis was evident August 8 and 9, and again August 19 and 20, unusual numbers of small lymphocytes showing in the smears, being normal on other dates. Temperatures showed an appreciable continued rise for six weeks after August 2, being practically all (a. m. and p. m.) between 39° and 40°. No visible external eruption followed. This is another case of an animal with small susceptibility phagocyting the organisms and showing no external eruption. The infection was undoubtedly slight.

Experiment XXII

Cavia cobaya, female, born in laboratory May 18 of parents from Jauja. Normal temperature 38.5°. Placed in cage July 24 with 12 living Phlebotomus, and left there till July 29 when it died, 2 of the Phlebotomus being still alive. Smear taken July 28, at 10.15 a. m., shows Bartonia bodies, as does also smear of autopsy thoracic-cavity blood. Autopsy liver, spleen, cord and lung smears show interesting conditions which require further study. Temperature at 9.30 a. m., July 28, was 39.8°. That this pig died from the infection induced by the bites of the Phlebotomus is not at all certain. Yet the temperature was high the day before, and autopsy of the digestive tract disclosed nothing abnormal.

Experiment XXIII

Canis caraibicus, male, about 5 months, from Chosica. Admitted to laboratory July 25. Average temperature under 38.5°. Normal weight about 2,900. Animal perfectly sound. Smear showed blood normal before experiment. Injected subcutaneously in right shoulder July 25 with 25 Phlebotomus in physiological solution. At 5 p. m., six hours after injection, temperature was 40°. Smears of July 27 (48 hours after injection) and August 20 show Bartonia bodies. Temperatures averaged a little above normal from July 25 to August 2, going from 39.3° to 40° during the first three days. Throughout August they were usually below normal, rarely above, after which they gradually rose to around normal. Weight July 26 was 2,041, and varied through August from 2,496 to 2,839, gradually rising. Leucytosis showed in smear of July 28. Small sores appeared suddenly on ear-lobes August 23, these bearing considerable resemblance to miliar eruptive sores, but only slightly raised. They continued on the ear-lobes, inside and out, increasing, drying, decreasing, and coming anew, until September 16 when most of the scabs had dropped. By October 6 there was no trace of the scars. Sections of these ear papules show a strong approximation to verruga histological structure. On October 12 injected subcutaneously in right shoulder with 50 Phlebotomus in physiological solution. Temperatures averaged but slightly above normal for three weeks following this last injection, but at times passed 39° and 40°. Weight increased gradually, and smears apparently showed neither Bartonia bodies nor anything abnormal. December 2, however, a small, hard, raised, uncolored nodule appeared suddenly on outer base of left foreleg, and by December 5 had become a typical hard nodular verruga to all appearances. It was excised and sectioned for study. The sections show a typical verruga histology. If the ear sores above described were verruga, as is probable, they did not confer immunity in this dog.

Experiment XXV

Canis criollus (tan-haired creole dog), male, about 6 months, from Chosica. Admitted to laboratory August 16. Average temperature under 38.5°. Normal weight about 3,800. Healthy, and smear showed blood normal before experiment. Placed in cage September 18 with 35 living Phlebotomus, to which were added 25 on September 23; 30 more on September 25; and 30 more on September 27, all from Verrugas Canyon. Removed from cage September 29, the Phlebotomus being practically all dead, notwithstanding the daily envelopment of the cage with wet cloths in the effort to prolong their lives, and the confinement of the dog between two wire desk baskets to prevent free-

dom of movement. Smears of September 26, 29, October 4 and 10 show Bartonia bodies. Smears also show leucocytosis beginning September 18 and gradually increasing to September 24, with a lapse to normal September 30 to October 9, appearing again slightly till October 14. Temperature average for thirty days following September 18 was 39°, reaching 40° on September 26, 40.6° on October 9, and remaining continuously close to 40° from September 23 to October 2. Weights showed quite steady gain from 3,472 on September 19 to 4,200 on October 14. No visible external eruption has yet appeared. This seems another case of a resistant animal phagocyting the verruga organisms. The experiment is the most ambitious one that it was possible to try at that season with the living Phlebotomus.

Experiment XXVI

Canis caraibicus, male, about 2 years, from Chosica. Admitted to laboratory August 18. Average temperature under 38.5°. Normal weight about 7,000. Very healthy, sound, smear showed blood normal before experiment. Injected subcutaneously September 4 with 50 Phlebotomus in physiological solution. Smear of September 7 shows Bartonia bodies. Leucocytosis is shown in smear of September 13. Temperature averaged 39.5° for the ten days succeeding September 6, reaching 40° on September 10 and 14, and being close to 40° from September 9 to 18. Weights showed fall only on September 7 and 8 of 300, and September 18 of 700, with these exceptions rising quite steadily from 6,550 on September 5 to 6,750 on September 17, but passing 7,000 on September 10 and 13. Up to October 16 dog had been quite normal and no external eruption had appeared. On latter date injected subcutaneously in right shoulder with strong dose of virus from nodular verrugas of man. This injection produced a marked effect, animal becoming dangerously ill and weak, with great pain and tenderness in right shoulder, where an immense abscess formed at point of injection involving the entire scapular region, these conditions continuing from October 18 to 23, when the abscess broke, and the dangerous effects persisting for some days after. Temperatures averaged only slightly above normal for the first ten days (.2° to .3° above), and below normal for the succeeding thirty days (.1° to .5° below). The raw surface resulting from breaking of abscess gradually healed, the edges of the lesion showing verrugas from November 2 to 13, these being constantly destroyed by the never-ending action of the animal's tongue. November 20 a small verruga had formed on forehead, and a larger one on outside of tip of right ear-lobe, both of which gradually increased to November 26 and 27 when they sloughed. November 22 showed eruptive scabbing on left ear-lobe and left jowl, these continu-

ing off and on till December 15, and later, with eruption lesions appearing on throat December 1. Smear of October 17, taken 24 hours after the virus injection, showed Bartonia bodies and leucocytosis. It may be stated here that the abscess in this and other cases was not due to defective technique, aseptic methods having been employed in all cases. The present very large abscess was doubtless due to septic material from the decomposition of tissues within the unbroken verrugas from which the virus was taken. This experiment indicates a certain degree of control of the infection from the Phlebotomus injection, no immunity being conferred; but inability to control the infection from the virus injection, which resulted in a generalized eruption, as distinguished from a purely localized one at point of injection.

Experiment XXVII

Canis caraibicus, male, about 18 months, from Lima. Admitted to laboratory August 28. Healthy, blood normal. Injected subcutaneously with 39 Phlebotomus in physiological solution, August 29, at 11.30 a. m. Temperatures rose on succeeding dates, reaching 39.5° on September 2. Weights decreased steadily from 3,575 on August 30 to 3,357 on September 3, except 3,646 and 3,605 on September 1 and 2. Smear of August 31, 46 hours after injection, shows Bartonia bodies rather numerously, also some leucocytosis. Dog very sick and weak August 30 to September 2, without appetite August 30 and 31. Chloroformed September 3 and various tissues preserved for sectioning.

Experiment XXVIII

Canis caraibicus, male, about ten months, from Chosica. Admitted to laboratory September 10. Average temperature well under 39°. Normal weight about 4,500. Healthy, blood normal before experiment. Testicular injection given at 10.30 a. m., October 5 with 100 Phlebotomus in physiological solution. Smear of October 6, taken at 8 a. m., shows Bartonia bodies, as do those of October 8 and 9. Weights decreased but temperatures remained practically normal. Abscess formed in testicle and broke October 9. Leucocytosis appeared in smears of October 9 to 11. Chloroformed dog October 12 and preserved tissues for sectioning.

This concludes the experiments to date. The writer wishes to acknowledge the valuable service rendered by his assistant on this work, Mr. George E. Nicholson. Unfortunately Mr. Nicholson contracted the disease as the result of being bitten by the Phlebotomus on the night of September 17 at Verrugas Canyon, an account of which was sent to *Entomological News* (vol. XXV, p. 40). His fever continued

for three weeks, during which time the Bartonia bodies were numerous, after which his temperature dropped below normal and remained so for about ten days, pains in the joints being prominent during this period. He received an intravenous injection of neosalvarsan on November 10, being about 30 cc. He has had no fever since November 15, nor has his blood shown Bartonia bodies. Eruption began to show December 24, and he has nearly regained his normal condition, the only symptoms persisting being reduced weight and somewhat reduced physical endurance.

As the result of the experience gained in the above experiments, hairless dogs appear to be the most satisfactory laboratory animals for verruga experimentation, at least in Peru. They are abundant and easily obtained, not too resistant, and the eruption can readily be seen upon them and photographed. Cebus monkeys are about equally susceptible, but very difficult to obtain and also to handle, while their thick coat of hair makes the finding and photographing of the eruption quite inconvenient. Rabbits are moderately susceptible, and guinea pigs rather less so. All of these animals appear more resistant to verruga than man.

The solution used in the injections was a citrated normal saline solution (Kronecker's artificial serum of Vogt and Yung, citrated). The Phlebotomus were placed on a glass slide with a little of this and crushed with a glass rod, the action being continued until the gnats were so finely ground up that all would pass through the needle of the syringe. The amount of solution used for an injection was usually 1 cc. In the case of the virus injections, the contents of the verrugas were squeezed out in the same solution and injected.

The writer calls especial attention to the finding of the Bartonia bodies, or of what seem morphologically identical with them, in the blood of laboratory animals. This is the first series of experiments that have shown this condition. Previous investigators who have succeeded in transmitting localized verruga to laboratory animals by injection of human virus uniformly claim that they have been unable to find Bartonia bodies in the blood, and that the characteristic blood changes known for human cases are absent in such animals. Whatever may be the true explanation of this, the writer wishes to emphasize the necessity for prolonged search in studies of Bartonia in the lower animals. It may often be necessary to search a single smear two or three hours, a half day or a whole day, in order to find a Bartonia body that may be present in it, and even this length of time may be insufficient. That this work is tedious in the extreme goes without saying, but when one realizes that a half dozen or even half hundred smears taken from an animal actually carrying Bartonia bodies in its blood at the time

may fail to contain a single one of these bodies, the necessity for prolonged search is apparent. The writer finds that the smears from his laboratory animals have never shown any approach to the abundance of the x-bodies often exhibited by smears from human cases. While the bodies are present in these animals, they usually exist in extremely small number compared with the average of human cases. An important point also is to take smears at least twice daily from the animal immediately following inoculation. The bodies may usually be found during the first three days. After the eruption has begun to appear, it is quite useless to look for them.

Despite repeated and persistent search from July to October, the early stages of the Phlebotomus have not yet been discovered. It has thus not been possible to attempt the rearing or breeding of them for infection experiments. While no doubt this could be accomplished with unlimited facilities, it is not at all necessary to the complete demonstration of the transmission, already secured, and its realization is not warranted by the conditions. At best it would probably be one of the most difficult entomological feats ever attempted.

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THE RELATION OF VARIATION IN THE NUMBER OF LARVAL STAGES TO SEX DEVELOPMENT IN THE GIPSY MOTH

By F. H. Mosher and R. T. Webber

During the season of 1912 a series of experiments on food plants was carried on at the Gipsy Moth Laboratory at Melrose Highlands, Mass. The main object of these experiments was to test the feeding of the gipsy moth on various plants; the results to be made use of in the thinning out of woodlands where this system of control could be adopted. Again, the results and data thus obtained could be used in comparison with this work in the field.

The food plants chosen for these experiments included those trees and shrubs which predominate throughout the infested territory. Some of the species selected were the oaks, hickories, maples and birches. There were many others of more or less importance, including some of the conifers, and such shrubs as witchhazel, cornus, barberry, etc., in all about fifty different species.

As the experiments neared completion, it became apparent that there was a difference in the stages in which the larvæ spun up previous to pupating, and upon close examination this peculiarity seemed to be more or less constant. A careful inspection of pupæ indicated that those larvæ that pupated in the fifth stage produced male moths, while those having a sixth stage developed females.

As there was little data at hand to show the constancy of this variation the results were noted and conclusions reserved until a later period.

The following year, 1913, the feeding experiments were repeated and the same method used as during the previous year, except that a more careful system of record keeping was devised and more attention was paid to the stage and pupation of caterpillars.

Method of Conducting Food Experiments

Under the single head of food plant experiments were grouped the following sub-experiments:

(1) The continuation of last year's experiments in which the eggs laid by the parent moth reared on a single food plant, were hatched and their progeny placed on the same food plant as last year.

(2) The combination food plant experiments in which the newly hatched larvæ were placed on a combination of foods and reared in that manner.

(3) Straight food plant experiments in which newly hatched larvæ were reared on a single food plant.

The larvæ used in the straight and combination feeding experiments were obtained from a newly infested locality at Barre, Mass. The colony is situated outside the generally infested territory and the larvæ were in a supposedly healthy condition.

In order that larvæ might be reared under the most natural conditions, all of the experiments were conducted in a large outdoor insectary.

There were about 174 trays used in the combined experiments which necessitated the use of about 17,000 caterpillars.

The eggs were hatched under natural conditions and 100 of the young larvae, as nearly uniform in size as possible, were placed in trays prepared for them.

The trays used in these experiments are a modification of the Fiske tray. They are of two sizes, one for the newly hatched larvæ, 6″ x 7″ x2″; and those used for the older larvæ, 12½″ x 12½″ x 2½″. The trays used in 1912 were wood frame with cloth bottom, but as considerable difficulty was experienced by the young larvæ in crawling over the cloth, a paraffined paper tray was substituted in 1913, and proved to be a vast improvement over the other. This paper tray when folded fitted snugly into wooden trays previously used. A band of tanglefoot 1 inch wide was placed on the upper inside margin of the trays to prevent the larvæ from escaping and the intrusion of others.

The food was kept fresh by placing the cut end or twigs bearing foliage in a receptacle filled with water. A specimen vial about 1 inch square and 3½ inches long and with the neck projecting at an angle of 45° was used for this purpose. The stem of foliage selected for food was thrust through a hole in a cork stopper which was inserted in the vial of water. By using a vial of this description the food was never in contact with sides of trays but lay evenly distributed across the center, thereby preventing all opportunity for escape of larvæ.

Each tray was inspected daily and a note made of the number of larvæ in each stage. The dead or dying caterpillars were removed and the tray cleaned of all excrement and other refuse. If at any time there was an excessive number of dead larvæ the living ones were transferred to a fresh tray. In this way sanitary conditions were maintained. A careful and complete record was also kept of the amount of food consumed by the larvæ and a note made of any changes affecting them.

The results of experiments in regard to sexual variation of larvæ confirmed those of last year and established the fact that the variation is constant so far as these experiments go. Of a few thousand larvæ that were under observation in the later stages, 560 transformed into chrysalids. Three hundred and twenty-five of these were males and

pupated in the fifth stage, while the remaining 235 passed into the sixth stage and developed female pupæ.

Available information bearing on this subject in other species is limited, although Doctor Dyar as quoted in Packard's text-book, p. 618, says that the average number of molts of lepidopterous larvæ is five, but six or seven stages are not infrequent. In rearing larvæ of *Hemerocampa* (*Orgyia*) *gulosa* Hy. Ed., he found that the males molt three or four times; the females always four. He also notes in *Psyche*, Vol. 5, p. 422, 1890, a somewhat similar variation in *Hemerocampa* (*Orgyia*) *definita* Pack. In this species the female larvæ require one more stage than the male.

In the First Annual Report of the State Entomologist of Missouri, 1869, p. 145, there is an account of Professor Riley's observations using larvæ of *Hemerocampa* (*Orgyia*) *leucostigma* S. & A., which was as follows: "About the middle of the month of May these eggs began to hatch. . . . Six days after the second molt, the third molt takes place with but little change in the appearance of the caterpillar. Further than that, the different colors become more bright and distinct, and different tufts still larger. Up to this time all the individuals of a brood had been alike, and of a size, so that it was impossible to distinguish the sexes. Six days from the third molt, however, the males measured not quite ¾ inch, and begin to spin their cocoons, while the females undergo a fourth molt about this time, and in about six days more they also spin up having acquired twice the size of the male when he spun up."

There seems to be little doubt but that the female larvæ of this species require an additional stage under normal conditions, but when subject to unnatural conditions this rule may not hold. That the larvæ of this species may vary considerably when fed sparingly is evidenced by the result of Miss Murtfeldt's experiment, which was carried on under the direction of Doctor Riley. In rearing these caterpillars and feeding them only enough to sustain life both males and females molted four times.[1]

On several occasions the scarcity of certain foods necessitated the stinting of caterpillars used in our experiments, but regardless of this fact the females passed through an additional larval stage.

In the March number of the *Entomologists Monthly Magazine*, 1887, V. 23, p. 224, there is an article by Dr. T. A. Chapman on the molting of *Notolophus* (*Orgyia*) *antiqua* Linn., and on rearing its larvæ he says: "The variability of molting occurs in the later stages. When we come to inquire into the significance of this variability, we meet at once with a very decided fact, and that is, that those that molt only three

[1] The Amer. Nat., Sept. 1873, V. 7, No. 9, p. 513.

times always produce male moths, that those that molt five times always produce female moths, those that molt four times produce both.

"It would thus appear that in *Notolophus* (*Orgyia*) *antiqua* Linn., the female molts one time more than the male, a circumstance that I have not seen noticed as occurring in any species, and that further the molts may vary by one."

The results obtained by Doctor Chapman's experiments using larvæ of *Notolophus* (*Orgyia*) *antiqua* Linn. are corroborated by Mr. J. Hillins,[1] who conducted an experiment using larvæ of the same species. Mr. Hillins found that one male molted three times; one female molted five times, and one male and one female molted four times.

The variation in the pupation of another species is noted by Prof. J. A. Lintner in his First Annual Report on the Insects of New York in 1882. In the lappet moth, *Tolype laricis* Fitch., he found that the males molted but three times while the females went through an additional stage.

Prof. C. H. Fernald's experiments using larvæ of the gipsy moth are noted in the Report on the Gipsy Moth written in 1896. Out of a batch of 55 newly hatched larvæ used in this experiment, 52 completed their transformations with the following results: 1 female molted six times, 29 females molted five times, and 9 females molted four times; 7 males molted five times, and 6 males molted four times.

According to the experiment just related there was no variation whatever in the larval form as to sex of this insect, and, moreover, another distinct stage was observed.

Morgan's "Experimental Zoölogy" has an interesting account by Pictet pertaining to the external appearance of some species of lepidopterous larvæ in regard to sex. In one instance he states (page 43), that in the larval form of *Porthetria* (*Ocneria*) *dispar*, the sexual dimorphism is marked, but adds that this only occurs in the fully formed caterpillars. In another paragraph he says, "The caterpillars of *P. dispar* normally transform into chrysalids after the sixth molt."

The results of these experiments by Pictet are at variance with our own in numerous ways. We have never observed any uniform difference between the two sexes in the larval form, except in the size of the head and body. Our experiments would indicate that only female pupæ developed from sixth stage larvæ.

In the sixth stage the velvety black stripes running vertically on each side of the clypeus are wider and more distinct but the size of the head although varying somewhat is considerably larger than in the fifth stage.

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[1] Entom. Month. Mag., 1881, V. 18, p. 86.

When caterpillars of this species prepare to pupate they cast their skins with the heads attached and these exuviæ are usually found with the pupæ suspended in silk spun prior to transforming. As the pupa and exuvia lie in close proximity to one another it is quite easy to distinguish the larval stage of the molted skin.

The results secured from larvæ reared in confinement were checked by observations in the field. Localities were selected with reference to their elevation, infestation, and food abundance.

At Wellesley, Mass., where the foliage was completely stripped, a careful inspection was made. Over fifty masses of pupæ were examined and while the percentage of female pupæ was small, a sufficient number was secured to verify the tray results. Fifteen sixth stage molted skins were attached to as many female pupæ, while 35 fifth stage caterpillars had transformed to male pupæ.

A larval collection was also made at this location. Eighty-two caterpillars all of which were in the prepupal stage were collected and brought to the laboratory. The stage of these was then determined and the fifth and sixth stage larvæ placed in separate trays in the insectary. Of the 56 fifth stage larvæ placed in one tray, 6 died of parasitism, 4 of disease, and the remaining 46 produced male pupæ. There were 26 sixth stage larvæ in the other tray, 3 died of parasitism, and the rest developed females. Although supplied with food the larvæ ate but little and all excepting those killed by parasites pupated within 48 hours.

At Salem, N. H., in a lightly infested area of mixed growth the results were practically the same. A few sixth stage molted skins were found attached to female pupæ and an equal number of fifth stage molted skins were closely intermingled with masses of male pupæ.

The last inspection was made at Allenstown, N. H. This infestation was of medium severity and located on a comparatively high elevation. As before several masses of pupæ were examined; the results of which were as follows: one mass contained 10 males and 6 female pupæ; one 14 males and 7 females, and another 8 males and 5 females. One-half mile from this point an inspection was made in a clear stand of pine lying adjacent to a mixed growth. Here several masses of pupæ were examined and the results confirmed the former observations.

It is not the purpose of this paper to dispute the conclusions reached by former investigators of this subject, nor do we claim that the gipsy moth larvæ do not sometimes pass through a seventh stage. We have never found it in our tray work and moreover the development of male and female pupæ from fifth and sixth stage larvæ has been constant in all our experiments. There can be no doubt but that the gipsy

moth is changing or has changed its habits in this country. Sixteen or seventeen years ago, when the Report on the Gipsy Moth was published by Forbush and Fernald, elm and barberry and many other trees and shrubs were considered very favorable food plants. In obscure locations where a slight infestation was detected and barberry was present the egg masses were usually found on that species, but this is seldom the case today, and this shrub is rarely infested. That the insect itself is less hardy than in the past is a surety and it is far more susceptible to disease. Again, there is a perceptible decrease in the average number of eggs laid by female moths except in newly infested territory, and as a rule full-grown larvæ secured at the present time are seldom as large as specimens taken at the time the above-mentioned report was published. These conditions may have some bearing on the results secured in our investigations from those published fifteen years ago.

NOTES ON FOREST INSECTS

By E. P. Felt, *Albany, N. Y.*

Both 1912 and 1913 were remarkable because of the abundance of the forest tent caterpillar, *Malacosoma disstria* Hubn. Last season it stripped oaks on Long Island, sugar maples in the Hudson and St. Lawrence valleys, and in certain Adirondack sections extensive areas of poplar were defoliated, a marked preference being shown for the tops of the taller trees. Pin or bird cherry, cornus and elms were partly stripped when near defoliated poplars, while red maple, birch, pine, balsam, spruce and hemlock were practically untouched. This is the second outbreak of the forest tent caterpillar in fifteen years, and in each instance there has been a superabundance of the apple tent caterpillar, *Malacosoma americana* Fabr. These species are so closely allied and are preyed upon to so large an extent by the same natural enemies, that it seems reasonable to expect synchronous outbreaks. We are of the opinion that insect parasites of the larvæ are among the more important controlling agents, though the increase in New York State, of injuries by leaf-feeding caterpillars in recent years suggests that the observed reduction in bird life during the past two decades may also have an important bearing on the problem.

The territory in the immediate vicinity of New York City has suffered greatly from the activity of a number of borers. The spotted hemlock borer, *Melanophila fulvoguttata* Harr., has destroyed many highly valued hemlocks; the two-lined chestnut borer, *Agrilus bilineatus* Weber, is killing the oaks, while the hickory bark beetle,

Eccoptogaster quadrispinosa Say, has swept out of existence thousands of hickories. It is well known that comparatively minor factors may turn the balance in favor of or against a destructive insect, and in connection with the above mentioned depredations we have looked for some general cause.

The outbreak by the hickory bark beetle in New York City and vicinity began about 1908, and an examination of the weather bureau records of that locality show an interesting condition. From 1906 to 1912 inclusive, there has been a deficient rainfall, except for 1907, at which time there was an excess of only half an inch. The total deficiency during this period amounted to 28.56 inches. The most marked deficiency for that period was in 1910, with a precipitation 8.75 inches below the normal, a reduction of approximately one-fifth. A scrutiny of the monthly precipitation shows that in 1906 the scarcity of rainfall occurred mostly from June to September, there being during these months from an inch to nearly an inch and a half less than the normal. The next year, 1907, although there was a slight increase in the annual rainfall, there was a considerable shortage for the months of July and August, this amounting respectively, to 3.36 and 2.05 inches. In 1908 there was a shortage of 1.56, 1.99 and 1.79 inches for the months of June, September and October, respectively. In 1909 there was a scarcity of rain during May, June and July, amounting respectively, to 1.46, .09 and 2.56 inches, there being an excess in August of 3.41 inches and a shortage in September of .93 inches. In 1910 there was a shortage in July, August and September amounting respectively, to 4.31, 2.40 and 2.16 inches with a slight excess in June of 1.84 inches. In 1911 there was a deficient rainfall in May, July and September amounting respectively, to 2.27, 2.99 and 2.08 inches, while in 1912 the deficiency from June to September, inclusive, was 2.09, 1.28, 1.76 and .21 inches for the four months in the order named.

Although the deficiency during this period was not as a whole very excessive, it will be noted that it was progressive and that the shrinkage in rainfall almost invariably came during the growing months and at times most likely to affect vegetation adversely. The general result in this region was abundantly evidenced by the unfavorable condition of the trees throughout the section, this being particularly marked in 1910 and 1911 and was accompanied by an abnormal scarcity of water. A number of trees, particularly soft maples and others standing in naturally moist, low localities, died, the major cause probably being scarcity of moisture.

With the above facts in mind it seems reasonable to believe that these unfavorable climatic conditions may have reacted upon the trees, reducing their normal resistance considerably and resulting in

conditions which were extremely favorable to the multiplication of bark borers. We would not be understood as holding that the above data were conclusive, though they may be very suggestive. It is obviously impractical at the present time to safeguard against drought, at least upon any extended scale, though the time may come when such data as that given above can be used to advantage in urging more comprehensive measures for the conservation of moisture and indirectly the control of certain classes of insect outbreaks.

The extensive plantings of white pines in the reforestation work of recent years in New York has produced conditions very favorable for injury by the white pine weevil, *Pissodes strobi* Peck. A number of requests for assistance in combating this pest were received, and the past season it was possible to carry out some coöperative experiments at Cooperstown which are at least worthy of record. In coöperation with Mr. Waldo C. Johnston of Cooperstown, the efficacy of hand collecting was tried on an area of fifty acres set with about 60,000 pines, the trees being approximately two to three feet high. Moderately large insect nets were used, the men simply tapping the plants so as to jar off the insects. The work was started a little late, namely, about May 21, and the trees carefully collected over four times at intervals of approximately four or five days. At the outset two to four weevils were caught per tree and toward the last only one or two insects per row of probably 400 trees were to be obtained. The cost of these four collections amounted to $64 or only $1.28 per acre. An examination, July 8, resulted in our not being able to find any weevils. It is probable that three collectings, particularly if the first was a little earlier, namely, in the first or second week in May and the other two at about ten-day intervals, would have resulted in capturing most of the weevils at less expense. There is no reason why, with improved devices, the cost of this operation could not be materially lowered. The fact that adults may live two or even three years and deposit eggs each season is a potent reason why collecting is more desirable than the destruction of infested shoots.

The above, taken in connection with experience of more than a decade ago, which showed that systematic collecting from a small group of pines, under what might be considered average woodland conditions, resulted in practical immunity from the pine weevil for a period of at least five years, leads us to believe that this method is worthy of a most thorough test.

ENTOMOLOGICAL WORK IN MISSOURI

By Leonard Haseman, *Department of Entomology, University of Missouri*

All are familiar with the able work of Riley so well described and illustrated in his memorable Missouri Reports. This work was in large part practical and being in a new field was largely original. Even at the present time his illustrations and more technical descriptions are made use of. Unfortunately Missouri and the Middle West was not then able to fully appreciate the value of his work, and after nine years it was discontinued and by the farmer largely forgotten. Comparatively few of the older Missourians now remember him and his work, though entomologists will not soon forget him.

His work as state entomologist was under the supervision of the State Board of Agriculture with headquarters at St. Louis, Mo., and after it was discontinued nothing was done in this state to control the insect pests until this department was established in 1895. At that time Stedman was appointed head of the department and an effort was made to investigate and improve entomological conditions in the state. Some headway was made, but the state is a large one and conditions were favorable for the work of insects and not always favorable for the work of control, so that from year to year conditions clearly grew worse. Funds were scarce in the early days, help difficult to get and such a thing as legal authority to control pests was unknown in the state. For the first few years after the work of this department began, a special effort was made to reach the farmer in a popular way, and while some little original work was done it was not of a technical nature. Agricultural conditions generally had materially improved since Riley began work here, so Stedman had a much better opportunity to reach the farmers and secure their coöperation. He began his work just after the San José scale was introduced into the state and while efforts were made to check it, they were met with lack of support and means, and consequently with failure. Had this department at that time done nothing more than stamp out this pest in the dozen or so orchards where it was then found, it would have far more than justified its existence. Since that time this pest has cost the state thousands of dollars, and will continue to cost it even more.

The writer has had charge of the entomological work here since 1910 and has found some of the original handicaps still existing. Lack of interest in insect control, and with it lack of support and assistance have always been a serious drawback in Missouri. This is being felt much less now than in former years though we need a dozen men in place of two to cope with the entomological conditions as they are now found in this state.

Since taking charge of the work the writer has attempted to take up those particular pests or groups of pests which are of greatest importance and which have required special study. So far our attention has been directed mostly to the smaller projects which have not required continuous observations extending over a period of several years. Such projects have been out of question, but we are hoping to be able in the near future to undertake some of these larger lines of work. In recent years the orchard insects have been given most attention since there are so many of them and the fruit growers are by no means familiar with them and the methods of control. It should be said that the Missouri horticulturist is far behind the general farmer and stock man as regards up-to-date scientific methods. They have never gotten together for the improvement of horticultural conditions as the other men have. This is well shown by their failure to secure adequate legislation for the improvement of horticulture until the last legislature. It is hoped, however, that the interest they have shown in securing this state aid is a true sign that they are awakening to the horticultural needs and that they will give every assistance to the uplifting of this badly neglected industry in Missouri.

In connection with the carrying out of the horticultural inspection law provision is made for educational work, and if it is possible to reach the horticulturists at all we should do so through this work. A keen interest is being shown in this new work and the prospects, for accomplishing something worth while for Missouri horticulture, are bright. In attempting to get this new line of work in operation this year most of the experiment station projects had to be neglected so that we have made but little progress with them this year. It was thought, however, that the opportunities opened by this new work would warrant the temporary neglect of the investigation work.

The work of this department at present covers the regular instruction in the university, which includes three or four classes each semester and from one hundred and twenty-five to one hundred and fifty students; the experiment station projects with the various insect pests and groups of pests affecting agriculture and the nursery inspection work which has been taken up in real earnest this year. These various lines of work are handled by the writer and one assistant or rather they attempt to handle them. We feel that we are making some headway, though it seems slow at times, and we are often inclined to envy those in other states who are able to concentrate all their efforts on a certain project and when finished turn to something else.

One important but much neglected line of entomological work in this state is the improvement of conditions in bee-keeping. The state has done almost nothing to improve conditions and the growing

demand for help is becoming very pronounced. This department has taken up the subject and is offering courses in bee-keeping and is undertaking investigations of problems of practical value to bee-keepers. The state has an apiary inspection law which is under the supervision of the State Board of Agriculture, but inadequate funds are provided and the work is therefore badly neglected. The experiment station is undertaking coöperative work with a view of lending some assistance to this industry.

In the future it shall be the aim of the writer to continue to expand the work of this department to meet the various new demands made on it, and with this increase of work it is hoped more help will be added so that we can do more and better work in Missouri. The appointment of an entomologist at the fruit experiment station in southern Missouri will help out, but there is still room for more entomologists. The field for practical as well as technical work here is unsurpassed, and it is a pleasure to labor under such conditions even with the small means at one's disposal. The state grows cotton in the south, corn and wheat in the north, and fruit everywhere; it has swamp, prairie and mountainous conditions with a varied fauna and flora scarcely touched by scientific students and as yet but slightly affected by the economic entomologist.

AN INCIDENT IN THE SEARCH FOR FOREIGN GIPSY MOTH PARASITES

By L. O. Howard

At a joint meeting of the Entomological Society of America and Section F of the A. A. A. S., held at Atlanta December 31, the writer read a paper on present conditions of the imported gipsy moth parasites in the course of which he laid aside his manuscript for a moment to tell an anecdote which he thought illustrated in a capital way, not only the difficulties to be met with in the field in a foreign country, but also the necessity not only for a thorough knowledge of the subject, but for imagination, fertility of resource, persistency, and energy on the part of the investigator, if the best results are to be reached.

After the meeting, and in fact during the discussion of the paper, several persons present urged me to write this story for publication in the Journal. I am afraid that Mr. Fiske would not like me to do it, but he is out in Africa at present and I cannot well wait for his permission. I think that Doctor Fernald and the others who asked me to write the story for publication can make such good use of it in their teaching work that I shall overlook Fiske's possible objections, and so here is the story about as I told it. It was *apropos* to a mention of the present condition in this country of *Limnerium disparidis*.

Down to the summer of 1911, this interesting and probably important parasite of the gipsy moth larva had been found only in Russia, and only about from forty to fifty specimens had been received, although it had received the attention of Pospielow in the early days and of Kincaid in his later journey to Russia. It is one of the species whose cocoon hangs suspended by a silken thread for a longer or shorter time, and it had been the contention of W. F. Fiske that the reason more were not found was that the thread breaks sooner or later and the cocoon drops to the ground and is only to be found on the surface of the ground.

On June 15, 1911, Fiske found himself in the middle of a forest at Gioia Tauro, Sicily, where he was studying the results of parasitism following a destructive outbreak of the gipsy moth, and, examining the remains of the caterpillars in an effort to tell just which parasite has killed them, his attention was continually attracted to larvæ hanging by their hind legs much as do those attacked by the wilt disease, with their bodies containing a few drops of blackish fluid. It was not wilt, he was certain from the first, and by tracing the various stages of decomposition backwards he was able to associate it with parasitism by Tachinids. Mingled with these dead larvæ were a number of others pellucid in appearance, looking much like brown-tail caterpillars killed by certain species of Apanteles. He puzzled over the phenomenon for a moment until, with a burst of incredulous enlightenment, he hit upon the solution. Holding his forceps exactly beneath such a larva, he let them drop to the ground, and at the exact spot where they struck, fully exposed, was a fine fresh cocoon of the long sought for and constantly despaired of Russian Limnerium, which, as above stated, was not known to exist outside of Russia. The experiment was repeated again and again with other caterpillars and in every instance with satisfactory results. In the afternoon of the same day, in another forest, he found the parasite much more abundant. In seven minutes he collected fifty on a bit of hard trodden path where all that fell were exposed, and a little bit to one side beneath an especially large and leafy tree he collected twenty-five from approximately one square yard of surface.

In the evening he talked the matter over with his native assistant and interpreter. He asked him to make a formal call on the mayor of the village; to present his compliments and tell him that Mr. Fiske would be pleased to call on him in person, but that he was not expert in the Italian language; that he desired to send the children of the commune into the public forest for the purpose of collecting a quantity of insects which abounded there and for which he had a particular use, and that he wanted to find some responsible person recommended by

the mayor who could be prevailed upon to receive these cocoons and pay for them at the rate of one centesimo each and forward them to Fiske at Portici. The assistant objected. He said it was not good form to call on the mayor in this unceremonious way and he refused to do it; so they finally compromised on the assessor. Again there were objections, but presently the assistant went, and came back with a queer look on his face. He had visited the assessor, it appeared, but the latter was very much inclined to think that he had either an idiot or a madman to deal with, but he said he would see the forest guards and see if there would likely be anything out of the way in allowing them to take advantage of such an offer.

The next morning about six o'clock two forest guards, two children, and a number of dogs proceeded with them to the forest where he gave them a demonstration of what he wanted. At first it was a flat failure. The guards could not find any cocoons themselves, nor could the boys, but by working hard himself and showing the boys where the cocoons lay he succeeded in getting them to pick up ten each, and rewarded them each with a couple of *soldi*. This livened things up a bit. The guards still could not find the cocoons, but the boys were beginning to see light, and before long they began to collect them in some numbers and kept Fiske fairly busy counting them and paying over *soldi*. The guards watched the transfer in growing amazement and enthusiasm, and at the end of an hour they all went back to town, the boys with about three *lire* between them and Fiske with three hundred parasite cocoons.

The guards stated to the assessor that the operation was of no possible danger to the forest, one of them insisting that the Limnerium was a species of fruit and that it grew on the foliage and that they themselves would gladly undertake the collection of the cocoons, or rather the payment for them, for the 10 per cent commission offered. But there was a *fiesta* on, and any chance of getting anything further done that day was out of the question. Fiske wanted the boys to go back and take some more boys with them, but they deserted him before they got half way back to town. The combination of a *lira* apiece and a *fiesta* on the self-same day was one which might never come again in a lifetime and they proposed to make the most of it.

The next morning at seven the forest guards returned and Fiske explained the full details of the scheme, offered to advance three hundred *lire* (about sixty dollars) and thereafter pay for every shipment as they were received at Portici. He set the limit of expenditure at fifteen hundred *lire* and the time at two weeks. The offer was accepted, and he hurried to Messina and cashed a check, returning the same night to sign the agreement. During the day the guards had

succeeded in getting eleven boys who had brought in 2,290 cocoons which were paid for on the spot. The next day the promise was that thirty boys should be sent out.

Fiske then returned to Naples, and the cocoons began to come from Gioia Tauro. Naples at this time was practically quarantined on account of the cholera. On the 6th of July a large lot had accumulated, and a boat of the Lloyd Sabaudo Company was to sail that day for New York. The company officials said that they would not take the parasites. Fiske called on the United States Consul, who told him he would do well to see the medical officer and get a certificate from him to the effect that he was willing to pass the packages and that there would be no trouble on their account in New York. The medical officer was out to luncheon, so he got the packages down from cold storage where they had been placed on receipt from Gioia Tauro, and then back to the Consul's, but there was no medical officer and he was told that it would be impossible to see him that afternoon because he was attending a conference. But the Consul wrote out a formal letter on fine stationery, and armed with this Fiske went back to the steamship authorities. They were impressed by the seal and the embossed heading, and while they were considering it the captain of the vessel came in and absolutely refused to allow the parasites to go in his refrigerator. He said that if Fiske would let them go in the hold of the vessel he might consider it perhaps, but not in the refrigerator.

Undaunted, Fiske started for the American Express Company office, calling en route at the International Sleeping Car Company's office, where he found that if he could start the sending on the 6.50 train that evening it might possibly go through by express train without missing any of the series of close connections, in time to be shipped on the French Line boat *La Lorraine* from Havre the following Saturday at 7 p. m., arriving in New York on the 15th or the day after it would have to leave Naples on the next possible boat that sailed.

But he had almost no money and it was 4 o'clock in the afternoon. Nevertheless, he went to the American Express Company offices and proposed that some one should undertake to see it through, charges to be collected from the State of Massachusetts or from the United States Government. The Traffic Manager admitted that he would like the trip, and said that he was well acquainted with the French language and the idiosyncracies of the French customs officials. The only difficulty was to get the parasites into some shape so that they would look like baggage, whereupon the head of the shipping department led the way to the rear of the offices and pointed out a pile of old trunks that had been blockading the passage for a long time. They were a motly lot, but when sorted over five were found that Fiske

thought would do. The bundles of parasites were unpacked and repacked in these five trunks, and, the superintendent of the office having approved, the traffic manager started with his five trunks and an additional hamper on the 6.50 train for Paris.

The rest of the story is that he made the journey without accident, got the trunks on the *La Lorraine*, where they were put into the refrigerating room. They arrived in New York on time, were met by the Government Despatch Agent, Mr. I. P. Roosa, hurried through the customs, and shipped to Melrose Highlands, where they arrived in admirable condition, and when Mr. Burgess unpacked them he found that practically all were sound.

No further comments on this incident are necessary.

NOTES ON THE LIFE HISTORY AND ECOLOGY OF TIPHIA INORNATA SAY

By George N. Wolcott, *Traveling Entomologist, Porto Rico Board of Agriculture*

The most important parasite, in the United States, of the grubs of the genus *Lachnosterna*, commonly known as "white grubs," is a black Scoliid wasp, *Tiphia inornata* Say. The work on which I have been engaged for the last year, September, 1912, to November, 1913, is the collection of sufficient numbers of the cocoons of *Tiphia inornata* to send to Porto Rico, in order that the species may be established there to aid in the control of the Porto Rican *Lachnosterna* grubs, which are a serious pest of sugar cane and other crops. For the successful collection of large numbers of *Tiphia* cocoons it was necessary to determine what factors limited the abundance of *Tiphia*, to the end that fields and localities might be found where these factors would be negligible, or nearly so, and cocoons would be present in abundance. The great majority of cocoons that have been collected are from localities not far from Urbana (my temporary headquarters) and Bloomington in central Illinois. All the observations here recorded, upon which are based the conclusions that are set forth in the following discussion, were made in central and northern Illinois, and are strictly applicable only to that region.

No attempt has been made to do any taxonomic work on *Tiphia*, for all the adults which emerge in Porto Rico from the cocoons sent from Illinois, after being used in breeding, are forwarded to Mr. S. A. Rohwer, for study and identification. The results of this work are not yet available. The life history notes are incomplete owing to the fact that the cocoons are sent to Porto Rico soon after collection, but observations to supplement the data here given may be expected

from the workers in Porto Rico — Mr. Thomas H. Jones and Mr. E. G. Smyth.

The literature dealing with other than the taxonomic features of *Tiphia inornata* is very meager. Dr. C. V. Riley in his Sixth Missouri Report (pp. 123–126) is the first to record anything of its parasitic habits, life history, abundance and parasitism by *Rhipiphorus pectinatus* Fabr. He also quotes the original description of the adult by Say and adds other descriptive notes, besides figuring the adult, larva and cocoon. Prof. S. A. Forbes in the Twenty-fourth Illinois Report (pp. 157–160) gives much interesting and definite information regarding the life history and habits, and the colored figure (Plate x) of the larva, cocoon and adult is very good. Mr. J. J. Davis in Farmers' Bul. 543 on "Common White Grubs" (pp. 15–16) figures the cocoon and gives some descriptive and life history notes. My attempt in this paper is to add to the life history data and descriptive notes given by others, but the discussion on the ecological factors is entirely original and has not been touched upon by previous writers.

Life History

The adult *Tiphia* is entirely black with many grayish hairs on the head, thorax and abdomen, and is easily distinguished from all other wasps by the color and the constriction between the first and second abdominal segments. The males are smaller and more slender than the females.

The female *Tiphia* is quite often observed on cement walks and on the ground, and indeed she spends the major portion of her time in or on the ground. She has a quick nervous walk, and her movements give one the impression that her eager search is without definite plan. Seldom is flight attempted, although the wings are used to help in short jumps or quick changes of direction. Earthworm holes and all sorts of cracks and holes are explored and often the wasp disappears in a hole in the earth that proves attractive. The females have slight difficulty in working their way through black heavy clay soil in good tilth and seem to be successful in finding grubs even in a field where they are not abundant. The grub is stung by the female wasp until it ceases to resist her attempts to deposit an egg on it, but the effect of the sting is only temporary. Indeed, the grub is often so active in burrowing through the soil that the egg, or even the young maggot, may be rubbed off. Grubs are often found with a brownish lesion showing the point of attachment of a maggot that has been rubbed off. The egg may be deposited on either the dorsal or ventral surface of the thorax of a one-third to fully grown grub. In one instance where the egg was deposited on the dorsal surface of the abdomen,

the maggot died while still very small. The ventral surface of the thorax appears to be a safer and more protected position for the deposition of the egg.

Incubation of the egg and the growth of the maggot while small takes several weeks, but the growth of the maggot from one-third to fully grown takes only two or three days. The grub seems not at all discommoded by the presence of the parasitic maggot while it is small, but when the maggot becomes about one third grown, the grub is less active, its movements being confined to a restricted area. Its feeble movements in the earth appear to have the effect of preparing a cell which is well adapted for the spinning of the cocoon of the parasitic larva. In practically all cases, all of the softer portions of the grub are absorbed by the parasite, and only the heavily chitinized head and legs and the shriveled skin of the grub are left.

In the earthen cell, which is practically empty after the destruction of the grub, the *Tiphia* larva spins its cocoon. This is an elongate pear-shaped affair, or it may be described more exactly as shaped like an Indian club or a summer squash with the neck eliminated. Indeed, comparison of its shape to that of a squash is more nearly correct, as the pointed tapering end is noticeably bent to one side. The cocoon is composed of downy silk of uniform texture, somewhat the color of khaki cloth. Often the color is darker or redder, but the variation is trifling. The silk of the smaller species of *Tiphia* is light yellow or flaxen in color. The color bleaches quickly in bright sunlight, and cocoons found in fields that have been plowed only one or two days previous show the side exposed to the sun faded to a light gray. The cocoon is loosely suspended in the cell by scattered strands of silk, but from the pointed end it is more firmly supported horizontally by a little button of silk in the outer layer of the cocoon. This little button is firmly attached to the side wall of the cell. Although the cocoon appears soft and downy, it is really quite firm underneath the loose outer network of silk, and the inner cocoon, while composed of silk of the same color, is very tightly woven. Entangled in the loose outer threads of the cocoon, the mandibles, skull (head case) and shriveled skin of the grub are usually to be found.

It has been supposed that the eggs are often deposited on grubs too small to furnish sufficient nourishment for the parasite maggot to become fully grown and in such cases small cocoons are formed. It is almost certain, however, that these smaller, flaxen colored cocoons are produced by another smaller species of *Tiphia,* which attacks only small grubs, as these small flabby cocoons are often found in fields where large grubs are abundant. The males of *Tiphia* are considerably smaller than the females and the cocoons from which they emerge are usually smaller than those of the females.

In the late fall a considerable period may elapse after the spinning of the cocoon before transformation to pupa takes place, in fact, pupation may not occur till spring. But if the cocoon is formed early in the fall transformation to adult may be immediate. Indeed, it appears that *Tiphia* may hibernate either as larva, pupa or adult inside the cocoon. During the summer, however, the cocoon is occupied only a short time between the spring and fall generations. The shed pupal skin contains a considerable amount of a dense white fluid, which later dries in a solid mass. If the adult is active in the cocoon, the pupal skin is ruptured and the dried white mass is ground to a powder which is often seen dusted over the adult *Tiphia* when newly emerged. Sometimes the adult is active before the fluid dries and it presents a sorry spectacle, when the cocoon is cut open, as it crawls out covered with large chunks of the dried fluid adhering. Probably with normal emergence the adult is seldom covered with this powder, for many cocoons are found from which the adults have emerged and the pupal skin remains undisturbed and unbroken in the pointed end of the cocoon.

All my observations indicate that invariably the adults emerge through a hole cut in the side of the cocoon towards the surface of the ground. Usually this is also the larger end of the cocoon, where the head is located, but cocoons have been found with the exit hole cut half way, or more, down the side. This condition is not usual, and occurs only in cocoons exposed by the plow. Plowing a field has a most decided effect on the emergence of the adults from the exposed cocoons. Adults which would otherwise hibernate in the cocoon, often emerge late in the fall. Spring plowing may produce an earlier emergence because of the unnatural warmth caused by a few days' exposure to the direct rays of the sun. In 1913, normal emergence was general at Bloomington, Ill., on May 14. Indeed, after this date very few cocoons could be found from which the adults had not emerged. As grubs parasitized with very small maggots are found as late as the middle of September, the evidence seems to indicate two generations during the year. Plowing is not usual during the summer and it is difficult to tell what the normal subterranean habits of *Tiphia* are. The adults which prematurely emerge from their cocoons late in the fall appear to perish without ovipositing, as parasitized grubs are never found as late as October 1 as far north as Bloomington and Urbana, Ill. Early fall plowing, and indeed fall plowing in general, must be very unfavorable to *Tiphia*. Even those cocoons which are deep in the ground and are not disturbed by the plow will be somewhat affected, but the majority of cocoons are formed less than six inches from the surface, or in that part of the soil which the grubs normally inhabit during the summer months, and these are exposed to the

weather and to the attacks of birds and predaceous mammals and insects.

Ecology

The various species of *Lachnosterna* in the Middle West are attacked by a considerable number of parasites and predators, but undoubtedly *Tiphia inornata* is the most important. I am convinced that under favorable circumstances *Tiphia* does greatly reduce the numbers of grubs and in some cases practically exterminates *Lachnosterna* from limited areas. The evidence is this: In some fields (near Randolph, Hendrix, White Heath, Ill., and at many other places) one will find many cocoons from which adults have emerged, a few in which adults are contained, and a very few grubs or beetles. Or in fields in which practical extinction of the grubs has taken place a year or more ago (near Weldon, Minooka, Seymour, Homer, Ill., and at other places) one can find only old rotten cocoons from which adults have emerged several months or a year previously, and few or no grubs and beetles.

The adult females of *Tiphia* are not strong fliers and they tend to remain in the field where their immature stages have been passed. When the grubs are abundant, no difficulty is experienced by the female *Tiphia* in finding sufficient numbers for the deposition of a large number of eggs. The rate of multiplication is rapid, for two generations of *Tiphia* probably occur during the summer. The supply of non-parasitized grubs in a field soon tends to become exhausted, necessitating a more careful search by the female to find a host for her eggs. The female, loath to search at great distances, eventually parasitizes practically all the grubs of suitable size in a field, until the dispersion of the females to new localities is necessary unless large numbers are to perish without depositing eggs. The males can fly long distances and are often collected feeding on the flowers of goldenrod and asters, but the females are less often found in these situations and apparently have difficulty in flying any great distance.

There are, however, several checks to an unusually great increase of *Tiphia* in restricted localities. Under favorable conditions, a fungus (probably *Isaria* sp.) causes a heavy mortality. Cocoons are often found covered with a weft of white mycelium densely covered with spores, spreading out into the surrounding earth. It has not yet been determined how infection by the fungus takes place—whether the spores only attack the parasite egg or maggot, or whether the mycelium is able to penetrate the cocoon. It may be that the fungus attacks *Tiphia* only when it is weakened by unfavorable conditions, such as sudden changes in temperature or too much or too little moisture, and is not pathogenic on healthy individuals. Naturally when *Tiphia* is most abundant the fungus will have the least difficulty in spreading and often nearly all the *Tiphia* in a field are killed in this way.

In addition to the fungus, *Tiphia* is attacked by at least two parasites—a bee-fly, *Exoprosopa fascipennis* Say (Bombyliidæ) and a beetle (Rhipiphoridæ). Riley identified the beetle emerging from cocoons collected in Missouri as *Rhipiphorus pectinatus* Fabr., but determinations have not yet been made of the beetles which emerged from cocoons collected in Illinois. The details of the life histories of neither of these parasites have ever been worked out. They seldom infest more than 1 or 2 per cent of the *Tiphia* cocoons. In one field, however (near Randolph, Ill.), a large number of the older cocoons in the field, instead of having a side emergence hole, showed the entire blunt end of the cocoon cut off. This was evidence of heavy parasitism by the Rhipiphorid, as *Exoprosopa* leaves its pupal case in a hole in the side much similar to that cut by the *Tiphia* adult. Cocoons showing no emergence hole are often found in the field pierced with a considerable number of small holes less than 1 mm. in diameter. The interior of such cocoons is entirely empty. What causes this is not known, although it may result from the grass roots which are often found wrapped round cocoons, or possibly the mites which often infest the grubs attack the cocoon when their normal host is destroyed by *Tiphia*. It has been suggested that ants might also cause this type of injury.

Although the parasites and the fungus are important in controlling the numbers of *Tiphia*, the most important check to the natural increase of the species is the lack of host grubs. *Lachnosterna* grubs are not present in noticeable abundance in the great majority of fields in central Illinois. Frequent plowing, rotation of crops, heavy pasturing of meadows and fields to horses, cattle and especially to hogs, which root in the soil after the grubs and destroy large numbers of them, and the absence of nearby trees to furnish a food supply to the adult beetles, may be mentioned as the more important checks on *Lachnosterna*.

The last mentioned factor seems to be of greater importance than is generally realized. The grubs of the species of *Lachnosterna* of which the adults prefer to feed on the leaves of willow and cottonwood (*Populus deltoides* Marshall) are almost invariably found abundant in those fields in which there are several large cottonwood trees. In the more hilly portions of Illinois, where fewer trees have been cut down, or even in fields near orchards or woods of oak, elm, ash, birch, linden, locust and walnut, *Lachnosterna* grubs are sufficiently abundant to cause serious loss to the farmers. Hedge (Osage orange), box elder and maple are the only three common trees that are not acceptable food plants to any *Lachnosterna* beetles, while cottonwood and willow are preferred by most of the common species. Oak and elm are a good third and fourth, but other trees are of minor importance. Despite the state-

ments in literature regarding the dispersion of the adults by flight to parts of the field distant from the food trees, the long flights observed are probably made by the males, for almost invariably grubs are most abundant near the food supply of the adults. In fields half a mile, or even quarter of a mile long, grubs will be abundant in the end near trees, and practically absent at the other end if no trees are near. Of course, grubs are not always abundant near trees, even when all other conditions seem favorable, and occasionally solitary grubs are found in fields a mile or more from the nearest food tree, and sometimes these grubs are parasitized, but these are exceptions. The comparative absence of trees throughout large areas of the more fertile and more valuable portions of Illinois, probably is the most important factor in limiting the abundance of *Lachnosterna*. If an abundance of grubs were to be found in most fields, the dispersion of *Tiphia* females would be greatly facilitated from a field in which most of the grubs have been parasitized, but as the supply of grubs is usually localized to a small area near a woods or clump of trees, the *Tiphia* remain in this locality, destroying all the grubs, and are themselves destroyed by the fungus which can more easily cause an epidemic among its crowded hosts, or else they perish without ovipositing while traveling to distant fields in search for grubs.

Practically all the fields from which the largest numbers of *Tiphia* cocoons have been collected were of these two types, either with several large cottonwood trees in the field or in a nearby hedgerow (near Champaign, Randolph, Wapella, Minooka, Hendrix, Ill.) or near oak or mixed woods (near White Heath and Monticello, Ill.). From only four other fields have collections of any size been made and these were of minor importance (near Rantoul south, Rantoul north, Monticello, Cerro Gordo, Ill.). Even in these cases, cottonwoods, willows, oaks or elms were not more than quarter of a mile away, and in at least two instances the fields had been unpastured meadows for several years prior to being plowed. In the great majority of all the fields, the plowing was for corn (5 to 7 inch deep) on land that had been in sod (clover, red and alsike, or grass) for two or more years and had not been pastured. The deep plowing made collection of cocoons possible and the other factors were of importance in producing an abundance of grubs—a potential host supply for a subsequent abundance of *Tiphia*.

In the more hilly and wooded sections of Illinois, the soil is not the typical black clay and brown silt loam of central Illinois, but is a gray clay of poorer texture, or a sandy, gravelly loam. To both of these types of soil another parasite of *Lachnosterna*, *Elis sexcincta* Fabr., seems to be better adapted, for in collections made near Galesburg,

Peoria, Allentown, Henry, Putnam, Sheridan, Rockford, Freeport, Winnebago and Belvidere, *Elis* is much more abundant and *Tiphia* is found in smaller numbers. Conversely, *Elis* is found in small numbers on the black clay and brown silt loam to which *Tiphia* is better adapted.

Still another factor which is of great importance in restricting the range of *Tiphia* is that only a single generation of the dominant species of *Lachnosterna* is present in some localities. For most species of *Lachnosterna* three years are required for the completion of the life cycle. The year that full grown grubs are abundant there would be an ample supply of hosts for *Tiphia*, but the next year only beetles, eggs and very small grubs would be present. Just this condition occurs in northwestern Illinois and every third year the farmers suffer great losses from the grubs. Probably the condition existing in this region some time ago was that parasites, such as *Tiphia* and *Elis*, were present, feeding in the years when the dominant species occurs as beetles or very small grubs, on the full grown grubs of some other species of *Lachnosterna*. In the year when the grubs of the dominant species were abundant, the numbers of *Tiphia* increased greatly. The next year the grubs of the non-dominant species would be only a meager supply to the large numbers of *Tiphia* and practically all the grubs would be parasitized. This would eliminate the non-dominant species, and in the coming years *Tiphia* would have no host in the years when the dominant species did not occur as large grubs, and it also would be exterminated. The elimination of the non-dominant species may also have been caused by the cutting down of trees that formed the food supply of their adults. Whatever caused the elimination of the non-dominant species, until conditions are again favorable for their increase no possible assistance can be expected from *Tiphia* in the destruction of the dominant species.

There appear to be at least five important factors controlling the abundance of *Tiphia inornata:* (1) Scarcity of large grubs in the years when the dominant species occurs as beetles and small grubs. (2) A permanent scarcity of grubs caused by unfavorable agricultural practices, or the absence of trees to furnish a food supply for the adults. (3) Unfavorable soil—which favors other parasites of *Lachnosterna.* (4) Parasites on *Tiphia* and the *Tiphia* fungus, *Isaria sp.* (5) Fall plowing—which causes premature emergence of adults and exposure of cocoons to predators.

FURTHER NOTES ON THE BREEDING OF THE TACHINID FLY, PARASITIC ON THE CANE BEETLE BORER[1]

By J. F. Illingworth, Ph.D., *Professor of Entomology, College of Hawaii, Honolulu, T. H.*

On April 21, 1913, I signed an agreement with Dr. Harold L. Lyon, who was acting as agent for the Colonial Sugar Refining Company, to undertake to transport from Hawaii and establish in the cane fields of Fiji, the Tachinid fly (*Ceromasia sphenophori*) which is parasitic on the cane beetle borer ([*Sphenophorus*] *Rhabdocnemis obscurus*).

I had just a month before my boat was to sail in which to make all preliminary arrangements, so I at once began a search of the various plantations on the Island of Oahu that I might collect as large a number of the parasites as possible. It was decided to carry the majority of the parasites in the form of maggots within the borer grubs since the adult flies are very difficult to keep alive in confinement. Previous investigation had shown that the parasitized grubs must be kept separate or they will quickly destroy each other. The most practical method, already developed, was the separation of the grubs into individual vials. Although the grubs when thus separated will live for several weeks without food, I decided to keep them well supplied, by placing bits of fresh cane in the vials from time to time as fast as they ate it. In this way I hoped to favor the development of the parasites. When the grubs were left in empty vials for some time, they were found to gradually decrease in size, and the resulting parasites were poorly developed.

During the collection of parasitized grubs many puparia of the flies were found inside the borer cocoons; these were all saved, hoping, that part of them at least would not emerge until I reached Fiji. However, some of the flies emerged from these daily, but a few lasted through.

It was with much difficulty that I found a locality in the vicinity of Honolulu that would furnish sufficient parasites for my needs. The evidences of the flies were everywhere, but they had done their work and gone. Empty puparia were found in most of the borer cocoons. Even in a small field of the Honolulu Plantation, which had been abandoned because of the abundance of borers, I found few grubs. Almost every stalk had been infested, but the empty puparia were all that remained to show that the flies had been there and done their work.

By much traveling from one end of the Island to the other I was able to collect, with assistants, about 1,000 of the borer grubs. I had to take a chance that most of them would be parasitized, since

[1] Contribution from The College of Hawaii.

they were all collected in fields where the flies were abundant. I estimated that if I could get these 1,000 grubs safely to Fiji, enough flies would emerge to fully stock several cages, and have a fair colony to liberate in the field at once.

During the voyage about 100 of the flies emerged from the puparia which had been found in the borer cocoons. It is rather interesting to note that the emergence of the flies invariably took place in the morning. If the weather was warm, the first flies appeared about daylight, and they continued to emerge for about three hours; on cool mornings, the emergence sometimes did not begin before 10 o'clock.

All of the flies that emerged during the trip to Suva were put into inverted glasses, on sheets of clean white paper. They were daily supplied with fresh slices of cane and bits of cotton batting saturated in water. By giving them moisture in this manner I avoided the difficulty of having them injure themselves by getting wet, as they invariably do when in close confinement. Even a drop of water on the paper soon resulted in several being upset and stuck in it.

By using greater care than one would need to give to a lot of babies, I was able to save practically all the flies that emerged en route.

On reaching Suva, the flies that were already emerged were quickly taken to the nearest of the plantations—twelve miles away, at Nausori, on the Rewa River—where cages were already prepared. Half of the flies were placed in one of the cages, which had been stocked with canes containing borer grubs; the other half were placed directly in one of the badly infested fields. This part of the island has a heavy annual rainfall and the cane is ripened with some difficulty. Since the failure of three previous attempts to introduce these Tachinid parasites at Nausori was attributed to the excessive humidity, we decided to take the greater part of our parasites to a drier section. We found Nadi district, which is situated about 100 miles from Suva, at the far end of the island, most perfectly suited to our needs. Two cages (Plate 10, Fig. 1.) were at once completed and stocked with grub-infested cane, about 50 flies were placed in each cage.

The remainder of the parasites which were, by this time, in the form of puparia, we decided to at once place in the field to emerge. The jars containing the puparia and damp frass were placed in a shelter and protected from ants, in a way similar to that used in Hawaii. We were unprepared, however, for the disaster that awaited us when we visited the field on the following morning—the rats (or mice) had gotten into the box and clawed out all the frass and puparia from the jars, destroying most of the flies. This left us with only our cages to fall back upon, but we had had the experience,—the liberating boxes must have mouse-proof screens.

Mating Observations

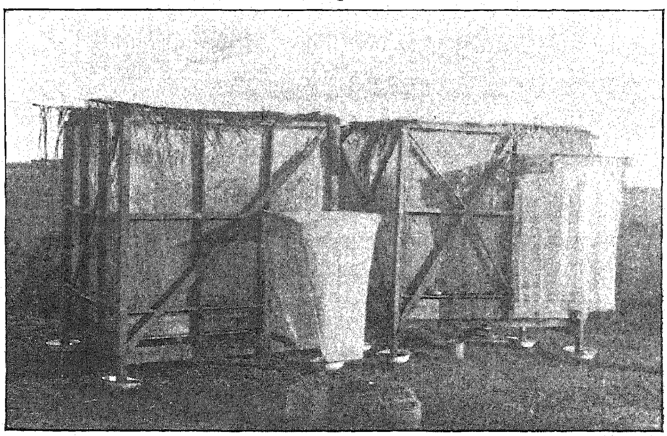
With all the study of the flies that we had done in Hawaii, their copulation had not been observed. In most instances, in the study of any economic species, a knowledge of the mating habits is very important. This is especially true in the present case, since we then knew when the flies were ready to reproduce. We first saw the flies mating when they were six days old, but later observation on the second brood showed that they begin mating on the same day that they emerge, in fact, when they are only about six or eight hours old.

A detailed account of these observations may be of value here. The male during copulation, stands on top of the female, his fore feet on either her head or thorax; the middle feet on the outspread wings; and the back clasping her abdomen. The mating, during the first day, was for very short periods, not more than half a minute at a time. It resembled very closely that of the ordinary house-fly. However, during the second day, they remain together for about four minutes, and, on the third day the average time required for copulation was a little over 18 minutes. Mating, evidently, is continued from time to time for a considerable period, since it was observed in the first instance on the sixth day.

Larva-positing

Mr. Frederick Muir, of the Hawaii Sugar Planters' Association, by careful dissection, estimated the number of eggs which the flies were able to produce. In one case he found 570 fully developed eggs in the uterus, and many others filling the fallopian tubes and ovaries. Thus the number of young possible for a fly to produce is upwards of 1,000. Mr. Muir also discovered that the eggs hatch while still in the uterus of the fly, and are deposited as living maggots. This is particularly favorable to their multiplication, since the little, active maggot at once enters the grub, and escapes the myriads of ants that swarm over the canes.

While these flies are rather quiet they appear to be very reticent about letting one see them larva-posit. After continued observations I was able to see this interesting process several times. The female was first noticed carefully examining one of the minute pin-holes, made by the borer grub through the rind of the cane. Her head was held very low, with the antennæ close against the surface of the cane. It is well known that the organs of smell in insects are located in the antennæ; so she was evidently smelling to decide whether a borer grub was near the opening. In about two seconds she touched the tip of her abdomen to the surface of the cane, twice, and deposited two active maggots. They were side by side, about 1 mm. from the pin-hole, and



Breeding cages at Nadi, Fiji. Nets over doors were for catching flies that escaped when cages were entered

Liberating boxes in the field at Nadi, Fiji

in moving about, quickly reached the opening and disappeared. The fly paid no attention to the larvæ after depositing them on the cane. In a number of other observations the flies were proved to have first located the borer grub, positively, near the pin-hole before depositing the maggot. This was done, in several instances, by cutting into the cane and finding it just inside the spot.

In one case a grub was removed in half an hour after the larvæ entered the pin-hole, and they were later found to be inside of him. Hence, they lose no time in boring their way into the living grub.

Continued Supply of Cane and Grubs

Another discovery that proved of great value to the breeding work was made while rearing the first brood of flies. A fresh quantity of cane containing borers was added to one of the cages, when the flies were 16 days old. Evidently they had pretty well gone over most of the borers already in the cage; at any rate, as soon as the fresh borers were introduced, they left the old canes and all congregated about the new ones. One might conclude that they were after the fresh supply of sugar, but this did not appear to be the case, for they became very active in their search for the pin-holes of the borers. This discovery indicated plainly that the flies must have a continued supply of fresh grubs if they are to give their maximum returns in breeding work. Our later results, when this was carried out, proved most gratifying.

Observations of the second brood gave us further information as to the time that must elapse after the flies emerge before larva-positing begins. In the case of the flies that copulated during the first day, they were seen intently examining the pin-holes of the borer when only two days old, and one was seen larva-positing on the third day.

Some of the flies in our cages remained alive and actively larva-positing through the entire period of six weeks, which is the ordinary time required for a generation to develop.

Light Relation

Most insects show a decided attraction to light, only a few seeking dark places. These Tachinid flies from their habit of living in the cane field, we would conclude, should have all degrees of light and shade.

In experiments in Honolulu it was soon learned that they were not contented in cages that were too dark, and refused to larva-posit. The same thing was partially true when the cages were provided with no shade. In our experiments on this point, in Fiji, we tried to supply as nearly field conditions as possible. In the cage that was so arranged we got our best results. This cage had a few leafy stalks of

cane through the center and at each side. Small, broad-leafed weeds from the cane fields were planted here and there around the edges. The flies seemed particularly fond of these plants, resting on the leaves in the sun, or going under them when it rained. The walls of the cage were made of good quality cheese cloth, and the top of mosquito net. The cloth on the sides shut out most of the strong wind on bad days, and the top net gave the flies a chance to get into extreme sunlight early in the morning or on cool days.

It was seen that the flies invariably sought the sunlight on the cane leaves or net early in the morning, and as the heat increased they gradually went further and further into the shade on the stalks, some even going to the moist shaded soil when the sun was too hot.

The flies are particularly active as the sun begins to warm up the cage, buzzing about near the top or anywhere they can get into direct sunlight. This is the time that they do their mating, hence it is very important that no obstruction shuts off the morning sun.

We found that a few cocoanut leaves tacked on the outside of the cage, gave an effect of light and shade that was very satisfactory before we got the cane growing inside. One has to use his judgment in this matter, however, and not everdo it. There must be at least as much surface where the sun can enter as is covered by the leaves. Later, as the green leaves developed inside, the cocoanut leaves were gradually removed, only two or three being retained on the top of the cage as a protection from the noonday sun.

Moisture

Flies in general require an almost continual water supply. They, like ourselves, can do for long periods without food, but quickly succumb to drought. Hence the matter of supplying moisture required careful regulation. After a good growth of cane was developed in the cages the problem was much simplified, for small drops of water are usually given off by the leaves in transpiration. During dry or windy days it was often necessary to spray the leaves several times. For this purpose an ordinary brass garden syringe with very fine holes was used. The soil, too, was kept well miostened so that the plants would thrive. In rainy weather the surplus water was provided for by boring drainage holes through the floor, and covering them with screens. Small pools of water in the cage are always a source of danger, for the flies sooner or later get into them and are destroyed.

Liberation of Flies in the Field

During the development of the flies in the cages a careful survey had been made of the various estates in the Nadi district, preparatory

to the liberations of the flies in the field. A field of ratoons was located, which was well advanced and badly infested with borers. Furthermore, the field was not to be cut for four or five months, in which case the flies would have opportunity to multiply greatly, and spread to adjoining fields of young cane which were already being infested by the beetles.

After six weeks, the parasitized canes were removed from the cages and placed in the field in upright boxes (Plate 10, Fig. 2). In order to protect these from ants, legs were attached and they were placed in tins of water. Exposure of the bare cane to the direct rays of the sun, at noonday, would quickly kill the enclosed parasites, so we finally developed a method of tacking cocoanut leaves to the boxes, which proved very satisfactory.

A few of the canes were opened up to form an estimate of the number of parasites:—87 borer cocoons opened, showed 75 that were parasitized—containing 172 fly puparia. This gave a result of 86 per cent parasitized.

During the second generation of the flies we put many more grubs into the cages than in our first experiment. Then, by putting in fresh cane and grubs daily, during the whole six weeks, we were able to more than treble the results of the first generation. From a total of 4,354 borer grubs that were put into the two cages, a careful estimate made by opening some of the canes as above, showed that we had fully 5,000 parasites developed. These were liberated in several fields of the Nadi district, about 1,000 or more being put together in each place.

Continuous Breeding

Since some of the flies of the second generation lived right through the period of six weeks, it was decided to date the canes as they were put into the cages each day, and remove them for the purpose of establishing colonies in the field at the end of about five weeks. By this method of adding new artificially-infested canes daily, and keeping always about 60 flies in each cage, we were able to remove 55 or 60 canes, containing fully 600 parasites, once a week. These parasitized canes were shipped to various parts of Fiji, wherever borer-infested fields were located. They were all exposed in upright boxes as shown above.

Enemies of the Tachinid Flies in the Field

It seems wonderful that the flies are able to reproduce at all in the fields when we see all of the organisms that prey upon them. It is only by their abundant powers of multiplication that they can overcome these natural enemies; the principal difficulty is in getting a

strong enough colony established that they may continue in spite of the loss. A brief discussion of these enemies may not be out of place here.

Before the flies escape from the cocoon of the beetle, many of them will be destroyed by rats. These rodents are particularly abundant in some fields and especially so under the moist climate conditions about Nausori. There I found many of the borer cocoons had been torn open by the rats in their search after the borer grubs. This loss will not be of any importance, however, after the flies become once established.

I should place the small brown ant (*Pheidole megacephala*) at the head of the list of mortal enemies of the flies. This is one case where his great industry will not be appreciated. At every stage of our breeding work we had to contend with these insects. They were on the ground about the cages in myriads; at the least opportunity they swarmed inside, if a mere thread was blown on to the protective water basins, we found that they had moved in their whole household by morning. We used carbon-bisulphide most effectively in such cases. We often noticed the adult flies attacked in the field soon after they emerged. Even a single ant, when he sets his jaw like a bull dog upon the fly's leg, seems to render it helpless, at this time. Often upon the stalk where the flies are emerging, we find a swarm of ants.

It is only because the borers plug the channel behind them and build an ant-proof cocoon, that the maggots are saved from destruction. The ants, even make short work of the borer itself, if it fails to take these precautions. Many times we had the ants get into our vials and bite holes in the grubs, even carrying them off piecemeal. The puparium of the fly, is usually found inside the cocoon of the borer; but even when free, in the borer channel, the ants appear unable to injure them.

Everywhere in the cane we found spiders; a large jumping species being most common. We did not see them in the act of springing upon one of our flies, but they were observed feeding in this way upon some of the other species of flies which are common in the cane field. These spiders never build webs but hide away in the leaf-sheaths of the cane and spring upon any unsuspecting insect that chances to alight near them. The habit of the Tachinid flies of searching about over the cane stalks renders them an easy prey to such attack.

Lizards, too, were rather common in the cane. One species, with feet fitted for an arboreal life, gave us considerable trouble by getting into our cages. Each one captured, showed on dissection, that he had his stomach filled with insects; but we never happened to find any of the Tachinid flies. Undoubtedly, however, he would take them if they chanced in his way, for he usually had several species of flies in him.

Dragon flies were very abundant in the field, especially during the evening. We often observed them circling about our liberating boxes, feeding upon the smaller insects. Though their principal food consists of flies, we never observed them in the act of catching one of the Tachinids.

Insectivorous birds appeared to be even a greater danger. Two common species were observed with some care—a small fly catcher, and a swallow. The first, flies in and out among the canes, and no doubt does considerable good in checking the ravages of several cane pests. His habits, nevertheless, render him a foe to the fly. The swallows feed entirely on the wing, over the cane or in the open places. Their beaks could be heard continually clipping together, registering the number of insects that they were taking in their swift circling flight. Probably the flies would receive little injury from them, except during the mating flights of the Tachinids, when they buzz about over the cane. Definite data on this subject could only be secured by making an examination of the stomach contents of a number of the birds that were killed after they had been feeding for some time.

There are a number of other organisms that are closely associated with the developing flies in the field which may prove to be detrimental to them. The earwigs that are ever present in the leaf-sheaths of the cane, are known to be often predaceous upon other insects. Cockroaches, too, are to be found everywhere, and are omnivorous feeders. The tunnels of the borer were often filled with mites. These attacked the emerging beetles in great numbers and were often found on the newly emerged flies. Whether or not any of these do serious injury to the Tachinids, needs further investigation.

Since the first flies were liberated during the latter part of July, it is rather early at this writing—November 12th—to find the parasites in the field. Though the flies were found to be established in Hawaii in about three months after they were liberated, we do not expect to discover any of the parasites in the field, in Fiji, until the cane is cut in December. When the flies are actually found breeding outside, the troublesome work with the cages can be discontinued.

Bibliography

The published notes on the breeding of these flies are principally found in three papers in the *Hawaiian Planters' Record* by Mr. Frederick Muir, as indicated below. In these papers Mr. Muir describes the many experiences and hardships of his search for the parasites, throughout the East Indies; and the final successful landing, in Honolulu, of a good colony of adult flies and puparia; the results of which have proved so beneficial to the sugar industry here.

1909. MUIR, F.—Report on the sugar cane borer in the Moluccas. The Hawaiian Planters' Record, Aug., p. 40–48, 1 map showing routes taken by Mr. Muir.

1909. MUIR, F.—Concluding report on travels in the Malay Archipelago, in search of parasites for the cane borer. The Hawaiian Planters' Record, Nov., p. 256–261.

1910. MUIR, F.—Report on second trip to British New Guinea to obtain a Tachinid fly, parasitic on the sugar cane beetle borer. The Hawaiian Planters' Record, Oct., p. 186–200, 5 figs. of fly.

1911. VILLENEUVE, DR. J.—Description of *Ceromasia sphenophori*. Wiener Entomologische Zeitung, Vol. XXX, p. 81.

A NOTE ON RHAGOLETIS POMONELLA IN BLUEBERRIES[1]

By WILLIAM C. WOODS

In the spring of 1913 the attention of the Maine Agricultural Experiment Station was called to a certain maggot infesting the blueberries in Washington County; and, accordingly, at the suggestion of Dr. Edith M. Patch, the writer made a few observations on this insect during the summer. Although the work was merely of a preliminary character, the adult was reared, and it seems possible that a brief statement of the situation may be of interest. When bred, the maggot proved to be *Rhagoletis pomonella* Walsh. This appears to be the first record from the blueberry, although at least twice it has been reported as bred from the huckleberry, once by Doctor Britton in 1906 (Fifth Report State Entomologist of Connecticut, 1905, p. 260), and again in 1910 by Doctor Smith (Report New Jersey State Museum for 1909, p. 802).

Washington County, which includes a considerable territory in southeastern Maine, is the principal home of the blueberry industry in the state. Roughly speaking, there is a large area of about 250,000 acres in this county naturally unforested, known as the "barrens," which has grown up almost entirely with blueberries. Three of the species, *Vaccinium pennsylvanicum*, *V. canadense*, and *V. vacillans*, were to be found attacked by the maggot during 1913. The plains are privately owned, but during the berry season, for a moderate rental, pickers are granted the right to gather the berries, most of which are sold to one or another of the eleven canneries located in the state.

July 30, when the berries were just beginning to ripen, was the first date on which the plains were visited. No maggots were in evidence, but six adult Trypetids were caught hovering around the berries. These flies resembled the apple maggot exactly, except that

[1]Papers from the Maine Agricultural Experiment Station: Entomology No. 73.

they were smaller. Specimens were submitted to Mr. C. W. Johnson of Boston, who very kindly determined them as undoubtedly *Rhagoletis pomonella*. It is interesting to note in this connection that the flies reared from huckleberries in Connecticut were also below the normal size of the apple forms.

On August 19, when the plains were again visited, six more adults were taken. Larvæ were by this time common on the plains. When the maggots are small, an infested berry cannot be distinguished by sight from a sound one, but usually when they have attained a fair size the fruit becomes very much shrivelled and shrunken. At all times, even when the larvæ are small, an infested berry can easily be distinguished by the touch, for it feels soft and mushy, and this is the surest external indication that it has been attacked. In an infested berry, the pulp becomes red and stringy. Maggots were found at this time in all stages from very small ones to those fully grown. The maggot appears to become full fed in one berry, which it leaves by an irregularly shaped exit hole through the skin, in order to pupate in the ground.

The berries are picked by a rake somewhat similar to that used for cranberries, and usually are given a preliminary winnowing in the field to remove the leaves, etc. Many of the infested berries are also blown out in this process as they are much lighter than the others. While the maggots were common to abundant on the plains, it should be stated that the blueberries grew so profusely, oftentimes being so plentiful as literally to color the ground blue, that only a small proportion of the fruit was infested. The testimony of the pickers varied greatly, but the opinion of most seemed to be that the maggots became more and more numerous as the season advanced, and that a wet season was particularly favorable to their development.

A third trip on September 5 showed the maggots still present and common in all stages.

Berries were placed under breeding cages on cheese cloth spread over moist dirt, and the larvæ that had left the berries, as well as the pupæ, were removed from these cages as follows:

MATERIAL COLLECTED JULY 30

29 pupæ on August 22.

MATERIAL COLLECTED AUGUST 19

	Aug. 22	Aug. 23	Aug. 25	Aug. 27	Aug. 28	Aug. 30	Sept. 2	Sept. 4	Sept. 8
Pupæ	7	4	4	33	7	22	38	10	50
Larvæ	4	6	20	3	7	2	7	2	

MATERIAL COLLECTED SEPTEMBER 5

	Sept. 9	Sept. 13	Sept. 15	Sept. 22	Sept. 24	Sept. 26
Pupæ	20	16	12	15	18	4
Larvæ	9	14	26	5	1	4

On February 12, 1914, an adult male emerged in the laboratory which is the same species as those taken on the barrens last summer, thus establishing beyond a doubt the fact that at least in southeastern Maine the maggot which breeds commonly in the blueberries is *Rhagoletis pomonella*.

INJURY TO TRUCK CROPS BY SPRING-TAILS[1]

(*Smynthurus* sp.)

By D. E. Fink, *Entomological Assistant [Truck Crop and Stored Product Insect Investigations], Bureau of Entomology, U. S. Dept. Agr.*

Recent Injury

For the past year, 1913-14, instances of injury by spring-tails to lettuce, spinach, and seedling cucumber came under the observation of the writer in the vicinity of Norfolk, Virginia. During the spring of 1913 a seedling bed of lettuce was found injured by a species of spring-tail near Mason Creek, Va. Later, seedling cucumbers just above ground were severely infested, the injury being so severe that a replanting was necessary. During the fall of 1913 spinach was infested with spring-tails but no injury was evident. Very late in autumn, a large number of the spinach plants began to turn yellow from the center outward. At this time the spring-tails were found in small numbers at the base of the plants and not on the foliage. Whether the spring-tails are concerned in the injury to spinach which is in this vicinity known as "blight" is as yet mere conjecture. But the fact that during the late fall and winter the spring-tails confine their attacks on the spinach to the petioles of the leaves would cause the latter to turn yellow and later give the observer the impression that it is due to "blight," as the leaves show no form of injury by insects.

On April 30 and May 1, 1914, seedling cucumbers were again found severely infested by spring-tails. These little pests have increased enormously since the past year and the cotyledons of cucumbers have in many instances been completely devoured as they appeared above ground. On May 2, 1914, a field of potatoes in Kempsville, Va., bearing vines only two inches above ground was found severely infested with spring-tails. They were found feeding on both the upper and lower surfaces of the leaves, as well as on the margins where the Colorado potato beetle (*Leptinotarsa 10-lineata* Say.) had been feeding. As many as 40 to 60 spring-tails were counted on a leaf, and several hundred to a plant. Although the spring-tails are easily disturbed, the

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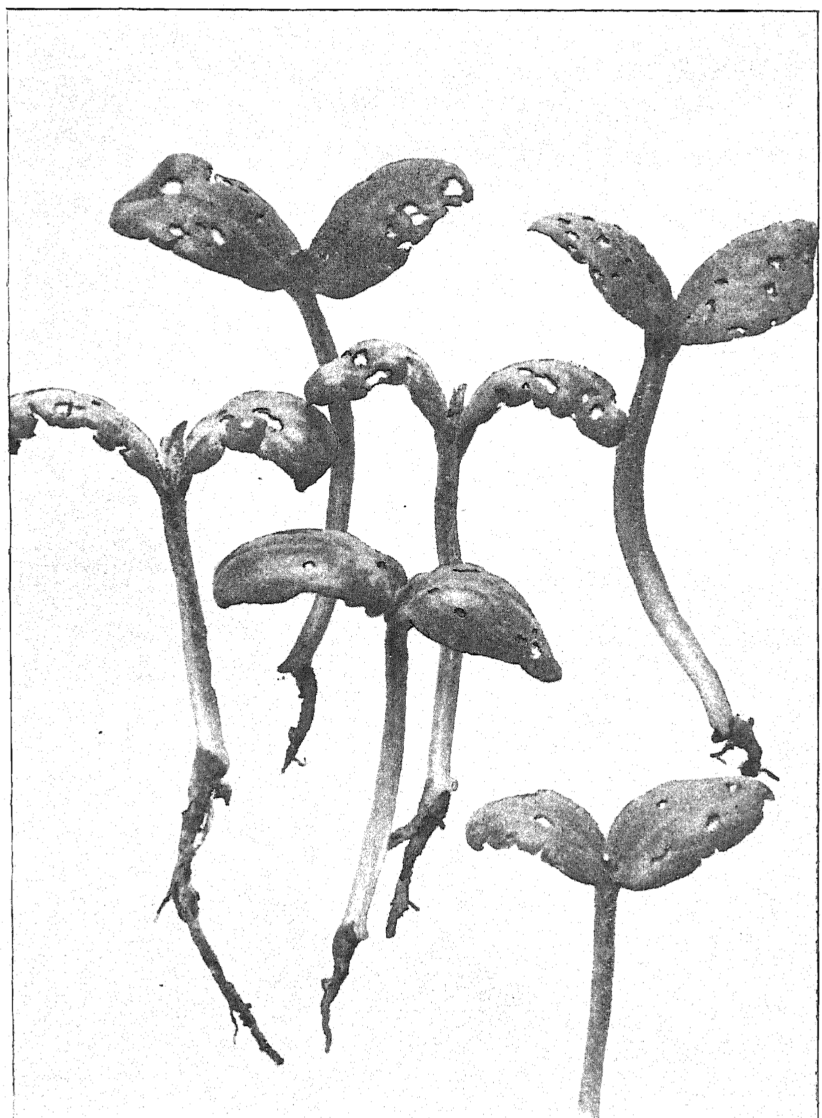


Seedling cucumbers injured by spring-tails, *Smynthurus* sp. (Original)

mere approach to a plant is sufficient cause for them to disappear, yet at times one may approach sufficiently close to observe them feeding, and by vibrating a leaf with the rhythm of the wind one may even tear it off finally and examine it by the aid of a lens. The injury done by the spring-tails is in the form of irregular holes sometimes eaten completely through, though more often a thin transparent layer of epidermis separates the upper from the lower surfaces. They also enlarge the holes made by flea-beetles that happen to be feeding on the leaves.

The species has been determined as a Smynthurus but cannot be positively identified. It is positively not the same as *Sm. hortensis.* It is a thysanuran of the suborder Collembola.

Food Plants

At the present writing this species of spring-tail has been observed and reported as feeding on the following food plants: Lettuce, spinach, turnip, kale, potato, tomato, cauliflower, cucumber and peas.

It has also been observed on beans and strawberries, but whether it feeds on these plants has not been determined.

Feeding on Potato Beetle Eggs

While making observations on the extent of their injury to the foliage of potato, hordes of spring-tails were found congregated around the egg masses of the Colorado potato beetle, feeding on them with as apparent relish as on the foliage.

Control Measures

During the spring of 1913 arsenite of zinc applied at the rate of 2 pounds to 50 gallons of water to seedling cucumbers proved successful in its control. It was also noticed that while using arsenite of zinc as a spray for this species that the arsenical acted as a repellent, driving the spring-tails from cucumber to peas which were grown between the rows, a common practice in tide-water Virginia. Arsenate of lead used in the proportion of 3 to 4 pounds in 50 gallons should also prove effective.

CONTRIBUTIONS TO THE LIFE HISTORY OF THE LESSER PEACH BORER IN OHIO

By J. L. King

During the summer of 1913 observations were made on the life history and habits of the lesser peach borer, *Synanthedon pictipes* G. & R., in the lake district of northern Ohio. The most important fact established by these observations is that this species has one full brood

and a partial second brood in the Lake Erie District. In the vicinity of Washington, D. C., and the more southern states evidence of a second brood has been previously noted[1] by other observers.

In Ohio the first moths from the hibernating larvæ appeared May 15, 1913, and from then on the moths gradually increased in numbers, reaching a maximum in mid-June. Their numbers then declined appreciably until early August, though at no time did they entirely disappear. This dearth seems to be followed by another period of increase during August at the same time that *Sanninoidea* has reached its maximum brood period in that district.

There is little doubt that the first period of maximum occurrence in June marks the height of the first or spring generation. This was determined by enclosing the trunks of twenty trees in wire-cloth cages and by making daily counts of the emerging moths from May 1 to August 20.

Eggs obtained from the spring generation of moths hatched in seven to eight days and larvæ were successfully reared through to the adult stage. The larvæ of the second or summer generation grow rapidly. The minimum period of growth was, in the case of a male, from July 26 to September 7, a period of 44 days. In another case of a male, from June 20 to August 12, or 54 days. A female of the same brood completed her cycle in 55 days. Other periods of development were 71 days for two females and one male. The longest period noted was from June 20 to September 7, or 80 days. The growth period varies much in the individuals of the same brood, much depending upon the environment. Thus, larvæ twelve days old measured from 2.57 mm. to 5 mm. in length. The same brood, thirty days old, had length variations of 6, 10, 14 and 17 mm. respectively. When 41 days old, three of these larvæ measured 20 mm. in length, being fully grown.

The larval development is complete in six instars. The following is the history of a single larvæ through its entire period of growth.

Instar 1. Hatched July 26—First ecdysis July 29. Length, when full grown, 2.75 mm.

Instar 2. July 29—Second ecdysis August 2. Length 4 mm.

Instar 3. August 2—Third ecdysis August 5. Length 6.5 mm.

Instar 4. August 5—Fourth ecdysis August 9 at 10.00 a. m. Length 8.5 mm.

Instar 5. August 9—Fifth ecdysis August 13. Length 13 mm.

Instar 6. August 13—Sixth and final larval ecdysis August 26. August 26 to September 7 in cocoon and pupa; September 7, emerged as adult male. Life cycle completed in 44 days.

From the foregoing data it should be noted that all second brood larvæ emerged as adults during August and the first week in September,

[1]Part IV, Bull. 68, Bur. Ent. U. S. D. A.

which time practically corresponds to the second period of maximum occurrence during August. Thus it seems very probable that the apparent increase in August marks the height of the second or summer generation. The habits of this species make it quite difficult to determine the numbers and duration of the brood. It seems not impossible that if the life cycle can be completed in forty-four days that there might even be a small third generation, though no further facts supporting such a possibility have been noted.

AN UNRECORDED PARASITE OF TOXOPTERA GRAMINUM

By F. M. WEBSTER, *Bureau of Entomology*

In the proceedings of the United States National Museum for 1888, page 641, the late Dr. Wm. H. Ashmead described *Wesmælia rileyi* "from six specimens in the Riley collection." No other information was given in connection with this description to indicate the locality from which the specimens came or the circumstances under which they were obtained. Doctor Ashmead, however, points out that "this remarkable insect agrees with the definition of this genus but seems out of place in the group and more closely allied with the group *Aphidiinæ*, where it may ultimately be placed."

In the proceedings of the Entomological Society of Washington, Vol. III, March, 1894, page 58, Doctor Ashmead erects a new genus, *Eupachylomma*, for this and another species which he himself discovered on Arlington Heights, on the Potomac River, in 1889. In this paper relative to *E. rileyi*, Doctor Ashmead states that "it was originally described from specimens in the collection of the national Museum, labeled No. 124, July 28, Collector, C. V. Riley, but no record of its habits or rearing could be found." In order to anticipate any further misconceptions, it may be stated that all of the specimens of this species, used in connection with the original description or in connection with this supplementary treatment of the species, were reared by myself at Oxford, Ind., July 25–28, 1884. These specimens appeared in a breeding cage to which growing wheat, from the fields, had been transplanted on the 12th of June previous. Shortly after this wheat had been transplanted the writer discovered *Toxoptera graminum* in the cage, as stated in bulletin No. 110, United States Department of Agriculture, Bureau of Entomology, page 15. On the 25th of June, a single individual of *Eupachylomma rileyi* appeared, followed by others. They were, with a single exception, submitted for determination August 19, 1884, as possible parasites of *Isosoma grande*, which was being reared in the same cage, the *Toxoptera* having

been accidentally introduced. In replying, Doctor Howard, then an assistant, now Chief of this Bureau, states that "Your number 124 is an *Aphidius* and was undoubtedly bred from *Toxoptera* and not from *Isosoma.*" That the species is parasitic upon *Toxoptera* is further indicated by the fact that no other aphids were to be found in this cage, either at that time or later, and this parasite did not appear in other cages where *Toxoptera* was not present. Number 124 to which Doctor Ashmead refers in his paper in the *Proceedings* of the Entomological Society of Washington, is my old original number. While one specimen was sent to Doctor Ashmead in corresponding with him on June 1, 1893, from Wooster, Ohio, this was from the same rearing as the original specimens sent to the Department, August 15, 1884.

On account of the obscurity that has surrounded this species it was unfortunately overlooked and not included in Bulletin No. 110, by myself and Mr. W. J. Phillips, on the Spring Grain-Aphis or Green Bug, *Toxoptera graminum.* It is also interesting to observe that the species has not again appeared in any of our rearings of *Toxoptera.*

A NEW LEUCOPIS WITH YELLOW ANTENNÆ

By J. M. Aldrich *La Fayette, Ind.*

Specific characters in the genus Leucopis are so obscure and uncertain that one is almost inclined to doubt whether the half-dozen nominal species from North America are not really all forms of the same one. I am quite unable to distribute my forty-odd specimens into species, either by the table given by Thompson (Canad. Ent., XLII, 238, 1910), or that of Melander (Jour. N.Y. Ent. Soc., XXI, 232, 1913). Some material lately sent me from the Bureau of Entomology for identification proves to be very distinct in having yellow antennæ, those of the described species being black in ground color. As the group is economically important, the larvæ being predaceous upon aphids and coccids, it seems desirable to publish a description of the new form.

Leucopis flavicornis n. sp. Head, thorax, and abdomen except basal segment cinereous pollinose, almost plumbeous, with silky lustre; antennæ except basal joint, tibiæ and tarsi except tips, yellow; thorax and abdomen without brown stripes or dots; palpi black.

Third antennal joint large, orbicular, the thickened basal joint of the arista also yellow; mesonotum almost uniformly beset with rather coarse, erect black hairs, a very narrow median line, however, bare and hence appearing paler; scutellum and hind edge of mesonotum destitute of these hairs. First abdominal segment brown except hind edge; the numerous hairs of the abdomen (coarser and more scattered than those of the thorax) arise mostly from good-sized black dots, which are not sharply defined. Trochanters yellow, femora brown to blackish along the middle. Length 2.2 mm.

Eight specimens, Brownsville, Texas; reared by R. A. Vickery from a colony of Pemphigus (probably *P. fraxinifolii*) taken from leaves of ash, May 10, 1910. Four specimens, including the type, are deposited in the United States National Museum.

The chætotaxy of the species is identical with that of others which I have examined, no specific differences appearing in any that I have noticed; it is as follows:

Head: post-vertical, ocellar, frontal and vibrissæ wanting; vertical two small pairs; one proclinate on middle of bucca.

Thorax: two pairs dorsocentral, far back, the anterior small; humeral 1; notopleural 2; presutural 1; sternopleural 1; intraalar 1 (behind); supraalar 2; scutellar two pairs. Thus the thorax has just 12 bristles on each side of the median line, the head three.

Scientific Notes

THE COTTON-WORM MOTH IN COLORADO. On the night of September 21, 1914, large numbers of moths appeared around the electric lights in Boulder, Colorado. Next morning, the night having been quite cool, hundreds of these insects were found resting on the ground in the vicinity of the lamps. Probably 90 per cent were *Heliothis obsoleta* Fab., and these consisted principally of var. *umbrosa*, with a sprinkling of var. *ochracea*. The other 10 per cent consisted mainly of *Alabama argillacea* Htn., which I had never seen in Boulder before. There was a single fine specimen of *Erinnyis ello* L. The remaining moths appeared to be of local origin.

Although the specimens were remarkably fresh and perfect, they must have come at least 500 miles. *H. obsoleta* is a Colorado species, but the great numbers present, associated with the undoubtedly southern forms, can only indicate a migratory flight.—T. D. A. COCKERELL, Boulder, Colorado.

News Letter No. 4, of the Bureau of Entomology, is a roster of all officers and men engaged in the work of the Bureau. The number totals 207, divided as follows:

Administration	8
Deciduous fruit insect investigations	31
Cereal and forage crop insect investigations	33
Southern field crop investigations	19
Forest insect investigations	15
Truck crop and stored insect investigations	14
Apicultural investigations	5
Tropical and sub-tropical insect investigations	9
Miscellaneous	
Identification and classification	8
Health of man	12
Health of animals	3
Spread of moths	41
Field work	9
	207

ANNUAL MEETING OF THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

The annual meeting of this Association and the sections on Apiary Inspection and Horticultural Inspection will be held at Philadelphia, Pa., beginning Monday, December 28, and extending through Wednesday, December 30, 1914.

An arrangement has been made whereby the annual meeting of the Entomological Society of America will be held on Thursday, December 31, and on Friday, January 1, 1915.

Members desiring to present papers should forward titles promptly on receipt of the regular notice concerning the meeting, which will be mailed by the secretary.

The general arrangement of the program follows:

Monday, December 28, at 1.30 p. m., opening session of the meeting of the American Association of Economic Entomologists. The regular business will be transacted and the address of the president will be presented at this session. At 8 p. m., the meeting of the section on Apiary Inspection will be held.

Tuesday, December 29, at 10 a. m. and 1 p. m., the regular sessions of the Association will be continued. Tuesday evening, at 8 p. m., the first session of the section on Horticultural Inspection will meet, and this will be followed by another meeting of this section at 10 a. m. on the following day.

Wednesday, at 1.30 p. m., the closing session of the Association will be held. Wednesday evening is left open temporarily, but in case the program is too long to dispose of at the sessions already arranged, papers will be presented at an evening session.

Thursday, December 31, at 10 a. m., the meeting of the Entomological Society of America will be opened, and another meeting of this society will be held at 1.30 p. m. At 8 p. m. the public address of the president of the Entomological Society of America will be given, and a smoker will be arranged by the entomological organizations of Philadelphia for all visiting entomologists.

Friday, January 1, 1915, the Entomological Society of America will hold its closing sessions.

A. F. Burgess,
Secretary.

JOURNAL OF ECONOMIC ENTOMOLOGY

OFFICIAL ORGAN AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

OCTOBER, 1914

The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—Eds.

Separates or reprints will be supplied authors at the following rates:

Number of pages	4	8	12	16	32
Price per hundred	$1.50	$3.50	$4.25	$4.75	$9.00
Additional hundreds	.25	.50	.75	.75	1.50

Covers suitably printed on first page only, 100 copies, $2.00, additional hundreds $.50. Plates inserted, $.50 per hundred. Folio reprints, the uncut folded pages (50 only) $.50. Carriage charges extra in all cases. Shipment by parcel post, express or freight as directed.

We hope in the next issue to practically clear up a number of papers which have been held for some months, owing to the necessity of giving precedence to the proceedings of the annual meetings. The Editor would add in further explanation that there has been an unusual amount of matter submitted for publication and, owing to our limited financial resources, only about so much could appear in each number.

We give on another page a brief note respecting one foreign serial. It is suspected that, owing to the war, some editors have been too busy to even send out an explanatory note. The gigantic struggle, with its accompanying waste of life, energy and resources, means a general and serious retrenchment in scientific work, especially among the nations most seriously involved. It is to be most earnestly hoped that the larger museums with their priceless treasures—their types and unpublished data—will escape the destruction that seems to have been the lot of some historical treasures. Even though this be the case, the imperative demand for men—a demand which will probably not be fully met in a generation—means the depletion of scientific staffs and the dropping by many of investigations which promise much for human welfare. We can all imagine the nearly finished manuscript laid aside, perhaps forever, and other papers held for years because of the sudden contraction in publication facilities—evident in the reduced size of numbers and possibly by the suspension of serials. We extend to our associates in the afflicted countries a heartfelt sympathy and we would voice the hope that there may be an early cessation of the deadly struggle and a speedy resumption of normal activities.

Reviews

Manual of Fruit Insects, by M. V. Slingerland and C. R. Crosby, xvi–503 pages, 396 text figures. New York. The MacMillan Company, 1914. $2.00 net.

Entomologists generally are to be congratulated that the unpublished notes and results of the studies of the late Professor Slingerland have here been put into permanent and usable form by Mr. Crosby.

The volume opens with a chapter of eight pages on general considerations in which are mentioned the vast amount of damage caused annually in the United States by fruit insects; their development; how they feed and how they may be controlled. Then follow concise accounts of the principal fruit insects, according to hosts, which in turn are listed in the order of their importance. Illustrations show the life stages of all the chief species. The space devoted to each kind of fruit is as follows: Apple insects, 204 pages; pear and quince insects, 29 pages; plum insects, 24 pages; peach insects, 38 pages; cherry insects, 11 pages; raspberry, blackberry and dewberry insects, 25 pages; currant and gooseberry insects, 22 pages; strawberry insects, 36 pages; grape insects, 63 pages; cranberry insects, 14 pages. The book ends with a chapter of 18 pages on insecticides, followed by an index of 11 pages.

The chapter on each food plant gives a brief account of the appearance, life history, injuries, and remedial treatment of each species, followed by a few references to the most important economic or descriptive literature.

At the end of each main division is a list of other insects also attacking that kind of fruit, each with a reference, to an account elsewhere in the book.

For the most part the treatment is clear and concise, yet comprehensive, thus including a vast amount of information between the covers of a moderate sized book. Most of the illustrations are from the well-known and excellent photographs of Professor Slingerland, though some have been furnished by others. Some are from pen drawings by Miss Anna C. Stryke. As a whole the figures are excellent and the volume is well-printed on good paper.

The work will be indispensable to all working entomologists and exceedingly useful to all farmers, gardeners and fruit growers. It is one of the series of Rural Manuals, edited by L. H. Bailey, and should find a place on the shelves of every agricultural and horticultural library.

W. E. B.

Current Notes

Conducted by the Associate Editor

Dr. H. E. Ewing has been elected assistant professor in entomology at the Iowa State College, Ames, Iowa.

The School of Agriculture, Purdue University, Indiana, now has 275 students taking work in entomology.

Mr. E. C. Cotton, assistant entomologist of the Tennessee Agricultural Experiment Station, has resigned to conduct a commercial orchard in Ohio.

Mr. A. L. Lovett has recently been promoted to the position of assistant professor in entomology at the Oregon Agricultural College, Corvallis, Oregon.

Mr. W. J. Schoene, who was recently appointed state and station entomologist at Blacksburg, Va., is now acting director of the Virginia Station.

Mr. G. F. Mozette, a 1914 graduate of the Oregon Agricultural College, has been appointed assistant in entomology at the Oregon Agricultural Experiment Station.

A fire, August 7, destroyed the entire equipment of the entomological department of the Agricultural Experiment Station (and College) at Stillwater, Oklahoma.

Mr. Tennyson D. Jarvis, associate professor of entomology in the Ontario Agricultural College at Guelph, has resigned to take charge of a fruit farm at Grimsby.

Mr. Frank E. Moeser, a collector and observer of lepidoptera, especially local Noctuidæ, died at his home in Buffalo, N. Y., May 15, at forty-five years of age.

Dr. Victor E. Shelford has recently been appointed associate professor of zoölogy in the University of Illinois on part time, and also biologist in the Illinois State Laboratory.

Professor G. M. Bentley, state entomologist of Tennessee and assistant entomologist of the station, has been appointed entomologist of the Station with Mr. H. R. Watts as assistant entomologist.

Dr. Charles C. Adams, of the University of Illinois, has been appointed assistant professor of Forest Zoölogy in the New York State College of Forestry at Syracuse University, Syracuse, N. Y.

Dr. C. Gordon Hewitt, Dominion Entomologist of Canada, inspected the field and parasite work on the gipsy moth and the brown-tail moth during the last week in June.

Mr. Loren B. Smith, a recent graduate of Cornell University, has been appointed assistant state entomologist of Virginia, and will be located at the Truck Crop Experiment Station at Norfolk.

Dr. W. D. Hunter, Bureau of Entomology, recently returned from a trip of inspection of the work in progress at Dallas, Texas, Tucson, Ariz., and in the Bitter Root Valley of Montana.

Mr. Thomas H. Jones, after an absence of some months for study in Washington, D. C., and Massachusetts, has returned to his former headquarters, The Sugar Producers' Experiment Station, Rio Piedras, P. R.

Mr. A. B. Duckett, Bureau of Entomology, has returned from a trip to New York and vicinity where he has been engaged in a preliminary investigation of the so-called "Argentine weevil."

Mr. E. Firmstone Heath, of The Hermitage, Cartwright, Manitoba, Can., died May 14, 1914, aged seventy-four years. Mr. Heath was a collector of insects, especially lepidoptera, and a frequent contributor to the *Canadian Entomologist.*

Mr. Russel Ferguson, assistant to the superintendent of moth work in Maine, with several assistants, is collecting parasites of the gipsy moth and the brown-tail moth for colonization in that state.

The following new men have been temporarily engaged by the Bureau of Entomology for work on the malarial survey at Mound, La. Ed. Foster, J. K. Thibault, Jr., W. W. Kimball and F. H. O'Neil.

Mr. D. E. Fink, Bureau of Entomology, has been engaged for some time on a new project—the fumigation of insects affecting stored products by means of ammonia gas. Considerable progress has been made.

Mr. Detmar W. Jones, a graduate of the Massachusetts Agricultural College, has been appointed scientific assistant, Bureau of Entomology, and assigned to parasite investigations at the Gipsy Moth Laboratory, Melrose Highlands, Mass.

Mr. E. O. Essig, Secretary of the State Horticultural Commission of California and Editor of the *Monthly Bulletin*, has resigned to accept a position in the entomological department at the University of California at Berkeley.

Mr. H. K. Laramore has been appointed field assistant, Bureau of Entomology, to work with Mr. High at Knox, Ind., in investigations of the onion thrips and other insects affecting onions and other vegetable and truck crops.

Mr. Leroy Childs, who for the past year has been assistant secretary of the California State Commission of Horticulture, has accepted a position as research assistant in entomology, at the Oregon Agricultural Experiment Station, Corvallis, Ore.

Mr. V. I. Safro, formerly assistant in the Bureau of Entomology, who recently resigned as assistant at the Oregon Agricultural College and Station, has been engaged as entomologist by the Kentucky Tobacco Product Company, Louisville, Ky.

Mr. H. B. Kirk, of the Bureau of Entomology, has recently accepted a position at the Laboratory of Economic Zoölogy, Harrisburg, Pa., where he will have charge of the photographic work and the breeding work of the insectary.

During the first week in June, Mr. A. F. Burgess visited the sections of New Brunswick and Nova Scotia which are known to be infested with the brown-tail moth, as the guest of Dr. C. Gordon Hewitt, Dominion Entomologist.

Mr. A. P. Sandles, Chairman of the Agricultural Commission of Ohio and Mr. N. E. Shaw, State Nursery Inspector of Ohio, spent several days in June investigating gipsy moth and brown-tail moth conditions in the infested area in New England.

Mr. Frank B. Herbert, of the University of California, has been appointed Entomological Ranger, Bureau of Entomology, to take effect November 1, and assigned to duty at the Pacific Slope Field Station at Placerville, California, under H. E. Burke, in charge.

The following new men have been temporarily engaged for tobacco hornworm demonstration work in Tennessee and Kentucky, by the Bureau of Entomology: O. M. Shelby, E. C. Crockett, A. D. Bosley, J. U. Gilmore, H. B. McKinney, F. G. Sorrels, R. K. Catlett, and J. E. McMurtrey.

Walter A. Price, a graduate of the Ohio State University, class of 1913, has been appointed assistant in entomology at Purdue University, LaFayette, Ind. Mr. Price entered upon his duties September 1. For the past year he has been assistant to Professor Osborn of Ohio State University, Columbus, Ohio.

Mr. John H. Pollock, of the Colorado Agricultural College has been appointed Entomological Ranger, Bureau of Entomology, to take effect September 1, and was assigned to duty at the Southern Field Station at Colorado Springs, Colorado, under W. D. Edmonston, in charge.

Mr. F. Paul Keen, of the University of California, has been appointed Entomological Ranger, Bureau of Entomology, to take effect August 1, and assigned to duty at the Pacific Slope Sub-Station at Ashland, Oregon, under John M. Miller, in charge of the station.

Mr. J. C. Evenden, of the Oregon State Agricultural College, has been appointed Entomological Ranger, Bureau of Entomology, to take effect October 1, and was assigned to duty at the Northern Rocky Mountain Field Station at Missoula, Montana, under Josef Brunner, in charge.

Mr. O. D. Ingall, a graduate of the Yale Forest School, who for several years was employed by the United States Forest Service, has been appointed assistant in Farm Management in the Bureau of Entomology and is conducting sylvicultural investigations in connection with the gipsy moth work.

Dr. Arnold V. Stubenrauch, who for several years has had charge of pomological investigations of the United States Department of Agriculture, and a member of the Federal Horticultural Board, has accepted a position in the University of California as head of the new division of pomology.

Mr. John E. Graf, Bureau of Entomology, who has been working on the potato-tuber moth, wireworms affecting sugar beet, and other insects affecting sugar beets and potatoes, with other members of the force of the Bureau, has removed from his old headquarters at Whittier to Pasadena, Cal.

Mr. Raphael Zon, Acting Chief of Forest Investigations in the United States Forest Service, spent several days in the gipsy moth infested territory examining the forest conditions with particular reference to the sylvicultural investigations which are being carried on coöperatively by the Bureau of Entomology and the Forest Service.

Mr. Carl Fuchs, one of the older entomologists of the Pacific coast and a well known Coleopterist, died June 11, at his home in Alameda, California, in his seventy-fifth year. For several years Mr. Fuchs was assistant curator of the entomological department of the California Academy of Sciences at San Francisco.

Mr. Lawson Caesar has been promoted to the position of associate professor; and Mr. A. W. Baker to that of lecturer; and Mr. G. J. Spencer to that of demonstrator, in entomology at the Ontario Agricultural College. All are graduates of the College, and have received the degree of B. S. A. from the University of Toronto.

Mr. L. S. McLaine, assistant to Dr. C. Gordon Hewitt, Dominion Entomologist of Canada, is stationed at the Gipsy Moth Laboratory for the summer. Mr. McLaine and three assistants are collecting parasites and natural enemies of the gipsy moth and the brown-tail moth for shipment to Nova Scotia and New Brunswick where an attempt will be made to colonize these species.

Dr. Henry H. Severin, who has been testing the poisoned bait spray to control the Mediterranean fruit fly and melon fly in the Hawaiian Islands, and the imported onion fly in Wisconsin, has accepted a temporary position with the Maine Agricultural Experiment Station to test out similar control measures against the currant or gooseberry fruit fly and the apple maggot or railroad worm.

The Review of Applied Entomology announces that in consequence of the state of war prevailing in Europe the July number of both series has not been dispatched and will not be dispatched to the United States until the British Post office is willing to accept them as free from risk. It has a large amount of material still in the office and continues to receive matter from the United States and there is no intention of suspending publication.

Beginning with the fiscal year 1915, a new project was undertaken by the Bureau of Entomology, namely, an investigation of the insects injurious to deciduous nursery stock, with especial reference to developing remedies and apparatus suitable for insect control under nursery growing conditions. Mr. A. J. Ackerman, of the Massachusetts Agricultural College, has been employed and assigned to this work, with headquarters for the present at West Chester, Pa.

Mr. E. R. Speyer of England, recently lecturer in economic entomology, and research officer in the diseases of trees to the Delegacy for Forestry at Oxford University, has been in the United States as a Carnegie scholar for the purpose of studying the larger problems in economic entomology, and particularly to study in the field with Dr. A. D. Hopkins the methods of controlling the Scolytidæ. Mr. Speyer has been appointed by the Ceylon Government to investigate the shot hole borer of tea in Ceylon.

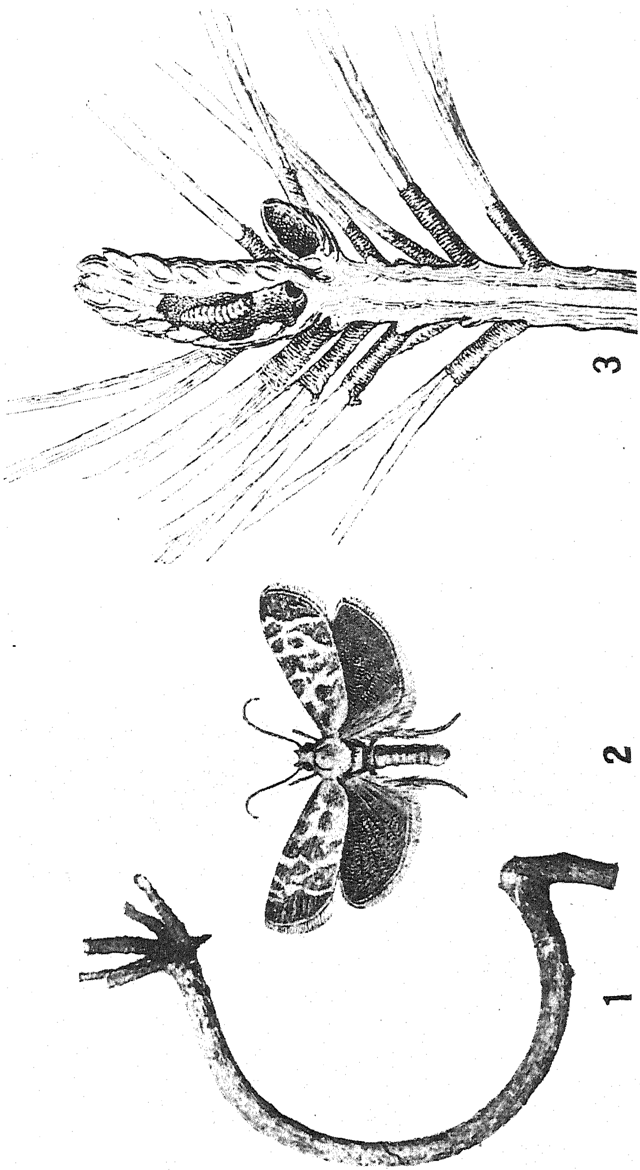
Mr. Harrison E. Smith is engaged in work for the Branch of Cereal and Forage Crop Insect Investigations for the Bureau of Entomology and is located for the summer at the Gipsy Moth Laboratory, Melrose Highlands, Mass. Mr. Smith is collecting *Calosoma sycophanta* and *Compsilura concinnata*, two imported natural enemies of the gipsy moth that have become well established in New England, and shipping large numbers of these species to New Mexico where an attempt will be made to colonize them as enemies of the range caterpillar.

The office, laboratories and apiary of the investigations in bee culture of the Bureau of Entomology have recently been moved to Drummond, Md., where convenient quarters have been obtained in a residence of ten rooms, well adapted to office and laboratory uses. The lot contains about three fourths of an acre, well suited for an apiary. In the cellar will be continued the work on wintering bees, formerly carried on at the zoölogical laboratory of the University of Pennsylvania. For the present the bacterial work in apiculture will remain at the insectary of the Bureau. The new laboratory may be reached via the Wisconsin Avenue trolley line.

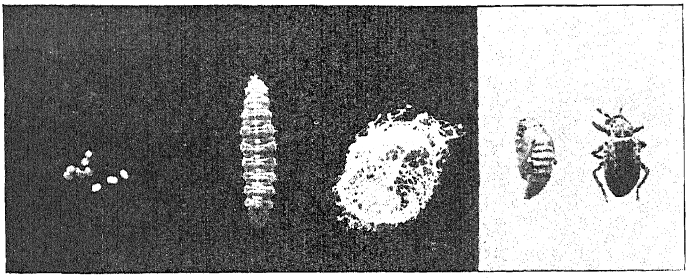
Mailed October 21, 1914.

DIRECTIONS TO BINDER.

In binding up full volumes of this magazine insert the opposite plate (Plate 9) to face page 340.



Evetria buoliana and its work.



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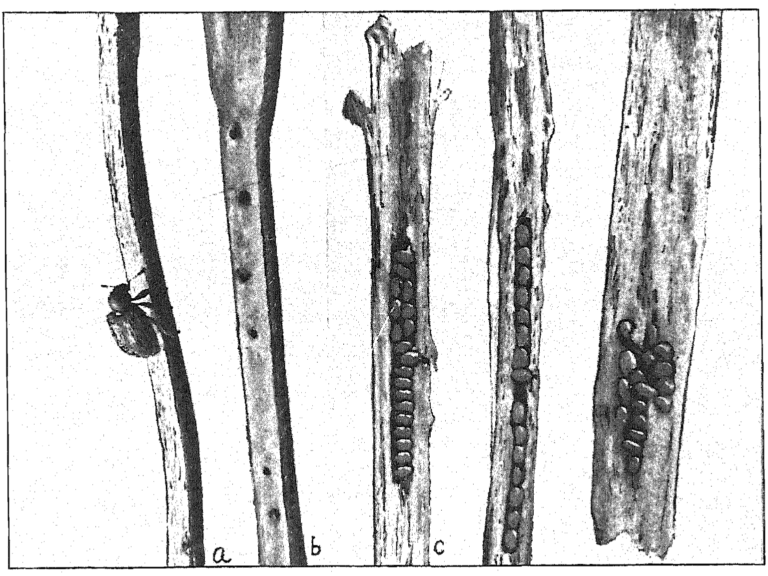

Fig. 1—Different stages of the alfalfa weevil
a–eggs; *b*–larva; *c*–cocoon; *d*–pupa; *e*–adult. All enlarged (original)

Fig. 2—Method of oviposition of the alfalfa weevil
a–beetle depositing eggs in stem of alfalfa; *b*–punctures in the stem made by the beetle in ovipositing; *c*–eggs in place in the cavity of the stem (original)

chart. The highest record for egg deposition was reached May 18, when an average of twenty-six eggs per female were deposited. This day also had the highest mean temperature of any day previous to June 6. The most of the eggs were deposited during May, and the rate of oviposition rapidly declined after the first of June, but was still influenced by changes in temperature, as shown by the record of June 24.

The temperature records were secured from the office of the United States Weather Bureau at Salt Lake City. The relation between the curves representing temperature variation and oviposition record is very noticeable, and the mean daily temperature seemingly affects the progress of oviposition until well into the summer.

The accompanying table shows the number of eggs deposited by each female first used in the oviposition experiments, or until she died and was replaced by another. The largest number of eggs deposited by any of these was 1,184, and the average for the series was 726 eggs per female. This is a fair estimate of the average number of eggs deposited by each female beetle in the fields during the season:

Oviposition Record of Sixteen Beetles in 1912 (*Phytonomus posticus* Gyll)

No.	Beginning of Deposition		End of Deposition		Date Beetle Died		No. of Eggs Deposited by Beetle
1	March	27	June	29	July	22	672
2	March	30	July	31	Sept.	4	779
3	March	29	May	29	June	6	520
4	April	6	June	13	June	14	675
5	April	1	June	27	June	29	933
6	April	3	July	19	Aug.	3	750
7	March	27	July	22	Oct.	9	669
8	April	6	June	10	June	27	401
9	April	3	July	8	July	13	972
10	April	6	April	29	May	8	138
11	April	6	June	1	June	21	332
12	March	30	July	1	Sept.	12	1005
13	March	30	July	8	Oct.	23	828
14	March	30	July	22	July	29	872
15	April	1	June	24	June	27	1184
16	April	1	July	8	Sept.	4	876
Average							726.4

In a series of experiments with eleven females collected from hibernation December 20, 1911, and allowed to deposit eggs in the warm laboratory room during the winter and spring, the average number of eggs deposited was 913. One beetle deposited 1,918 eggs.

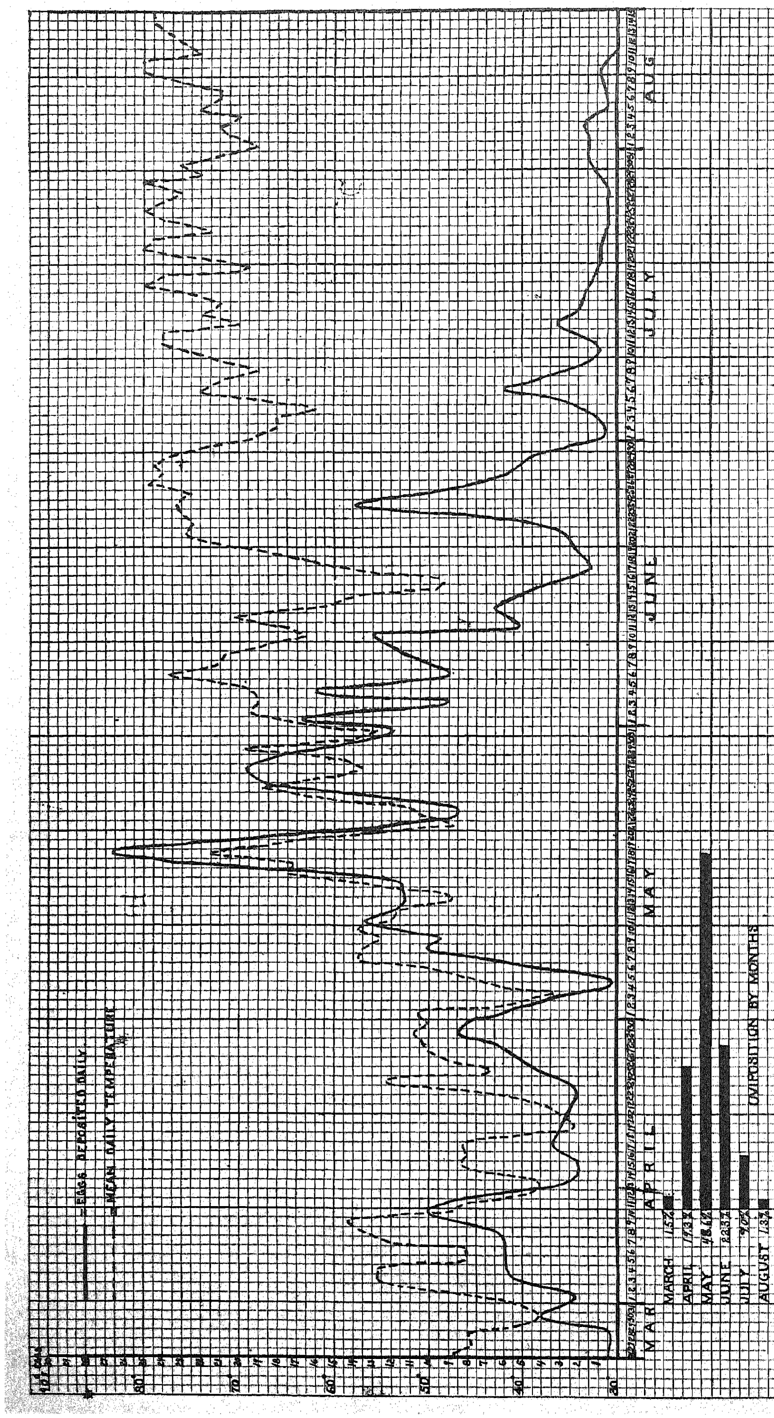

Fig. 22—Curves showing the distribution of oviposition of the alfalfa weevil (*Phytonomus posticus* Gyll) during the season of 1912, and the effect of change in temperature upon the rate of oviposition

Continous line represents the average number of eggs deposited daily by each beetle, taken from the record of 16 females throughout the season
Broken line represents the mean daily temperature during the oviposition period

If we take the average number deposited in the 1912 experiments, and figure the rate of multiplication, there will be present at the end of the second generation 65,957 individuals, providing that one half of them are females and one half reach maturity. It is highly probable in the inter-mountain country that much less than one half reach maturity and deposit eggs the following season, since many perish in the immature stages in fields of alfalfa after the removal of the first crop, and many which reach maturity are later carried by the wind into mountains and desert wastes where they must perish for want of suitable food. Among the individual beetles used in the 1912 experiments, oviposition did not progress uninterrupted throughout the season, but the "resting periods" were of short duration, and in most cases the egg deposition was fairly constant during the greater part of the season. Copulation occurred repeatedly during the entire period of oviposition, and all eggs saved for hatching showed a very small percentage of them to be infertile.

In the autumn of 1912 beetles which emerged from their cocoons June 10 to 13, deposited eggs in out-door cages the latter half of October. This, to all appearances, is the beginning of another generation, later interrupted by the approach of winter, but continued in the spring. Females taken from the fields, during November and December, deposited eggs in the laboratory continuously through the winter and spring. Eggs deposited in the autumn of 1911 were killed by the winter temperature, and, so far as known, all eggs deposited in the autumn either perish before hatching or the larvæ are killed by the winter, depending upon the weather conditions.

This represents, so far as known, the first accurate records of the average number of eggs deposited by the alfalfa weevil throughout the growing season, and the direct dependence of the same upon temperature. It would be natural to presume that a higher degree of prolificacy would prevail should the beetles become established in a region having a warmer climate and a longer growing season than characterizes the present area of infestation.

Acknowledgments are due to Mr. E. J. Vosler, now of the California State Insectary, for his assistance in taking records at times when the writer was away from the laboratory. Also to Mr. G. I. Reeves of the Bureau of Entomology for valuable suggestions in photography.

NOTES ON THE LIFE HISTORY OF PROSPALTELLA PERNICIOSI TOWER[1]

By Daniel G. Tower, M. Sc., *Amherst, Massachusetts*

Introduction

The following notes were taken during the early spring, fall and winter of 1913, and the spring of 1914.

This parasite, a description of which, both male and female, was published in the Ann. Ent. Soc. Am., vol. VI, No. I, pp. 125–126, is a true internal parasite, the larval forms living within the body tissues of its host, the female San José scale, *Aspidiotus perniciosus* Comst., except during the last part of the second larval stage as at this time the entire contents of the host are consumed by the larva, which, after passing its waste, pupates in the empty skin of the scale.

Both male and female parasites emerge from the empty skins of second-stage and early third-stage female scales, but by far the largest number emerge from second-stage scales.

The following description of the life cycle of the parasite, which has been worked out, is that of a parasite maturing in and emerging from a second stage scale. No doubt the development of those which emerge from third stage scales is the same.

The Egg

Developed eggs are readily seen within the abdomen of the female parasite when examined under the microscope at the time of emergence, and many are even fully developed in the late pupal stage. They can also be examined as found in the bodies of first-stage and early second-stage scales.

The egg is ovate and has a distinct micropyle at the smaller end. The chorion is smooth and hyaline and the nucleus, located at the larger end, and the opaque granules, with which the egg is filled, show through.

The egg measures .085 mm. in length and .04 mm. in width.

The number of eggs deposited by an individual is not known, but 1,364 developed eggs were obtained from twenty females selected as they emerged, giving an average of sixty-eight developed eggs apiece. Of the twenty females examined, the smallest and largest number of eggs found in a single specimen was forty-six and 102, respectively, and in most of these females there were still undeveloped eggs.

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[1] Contribution [from the Entomological Laboratory, Massachusetts Agricultural College.

Development of the Egg

The egg is usually found lying about medially in the scale and slightly nearer the pygidium end of the scale than the head end, although it may be found almost anywhere in the body. Here the egg swells in embryonic development to two to three times its size when laid and the young larva may be seen forming within it. The larva is practically fully developed before hatching and lies curled within the egg. On hatching it straightens itself out in the egg and the chorion, which has become very thin, is ruptured, allowing the larva to escape into the body of its host.

First Larval Stage

The larva, when hatched, is large compared with its host. Its mouth-parts, which were fully formed while in the egg, now become fully chitinized and the mandibles, which are the most prominent parts, are very sharp, strongly chitinized and decidedly hook-like.

The tracheal system, which lies close to the body surface and which was only partially filled with air when the larva was in the egg, now becomes filled and the two longitudinal main trunks, which lie on either side of the body meeting anteriorly and posteriorly, forming an oval, each show ten short stub-like branches.

Apparently there are thirteen body segments, the thirteenth or posterior segment lying partly within the basal portion of the tail. A distinct head region containing the mouth-parts is marked off. This region in the newly hatched larva is of the same diameter as the body, but subsequent growth enlarges the body, while the diameter of the head increases little if any. Thus the head region becomes more definitely marked off.

The tail is about one-fifth the length of the larva. It is seen in the embryonic larva lying close to the body, while in the hatched larva it is extended and is used for propulsion inside the host. A number of pointed folds or hyaline scales, which protrude slightly from the surface and point backward, are placed irregularly on the surface of the tail and these doubtless make the tail an even more efficient organ of propulsion.

Oxygen must be obtained through the skin or from the food eaten, as the larva lives submerged in a liquid medium having no connection with the tracheal system of its host or with the exterior, also its own tracheal system does not connect with the outside of its own body.

Feeding is carried on by means of a sucking pharynx aided by the mandibles. The ventral surface of the pharynx is a rigid chitinous

plate extending from the mouth backwards to the posterior limits of the head. The membraneous dorsal wall of the pharynx is raised from the ventral wall of the pharynx by muscles situated in the dorsal region of the head. These induce wave-like motions in the dorsal wall of the pharynx, which suck in and carry the food through the pharynx to the œsophagus. Here it is passed down into the stomach by the contracting action of the walls of the œsophagus.

The stomach is a blind sac in which the food is, during the early life of this stage, churned or rolled about by the movements of the larva. Later the stomach muscles become developed and constrictions, which run in waves from one end to the other, roll and turn the food content over and over, thus aiding digestion.

The posterior portion of the alimentary tract or proctodæum is scarcely developed and there is no external opening, as waste is not passed during this stage.

The larva at first feeds on the blood and smaller fat globules and avoids the vital parts as the growth of the second stage scale is not arrested until maturity has been reached. At this time usually the first larval stage of the parasite becomes full grown and apparently attacks, during its last days of growth, the vital parts of the scale, thus interfering with its normal functions and preventing the second molt of the scale from taking place. The scale, which previous to this time has been normal in its development, now becomes swollen and distended and at this time begins to turn from its normal lemon yellow to a light orange. The first molt of the parasite usually takes place at approximately the same time that the scale takes on the orange color.

The molting of this form terminates the first larval stage.

Second Larval Stage

This larval form is tail-less and its mandibles are not at first well developed, but soon grow to full size and become chitinized. The head region is indistinct and the body segments are practically indistinguishable.

The tracheal system lies deep within the body and at first contains little or no air, but soon becomes filled and develops rapidly. The first, second and fourth to ninth inclusive short branches of each longitudinal main trunk grow rapidly and terminally at the surface of the body develop spiracles, while the third and tenth branches remain short and do not develop spiracles. The two main longitudinal trunks are joined posteriorly and anteriorly as in the first larval stage and from these and the bases of the twenty branches are given off numerous branches which ramify to all parts of the body.

Respiration during the early life of this form is carried on in the same way as that of the first larval stage, but later as the fluid contents of the scale is consumed and an air space forms in the scale, some of the spiracles which have developed no doubt open and function. Without doubt by the time all the fluid content of the scale is consumed all the spiracles are fully developed and function.

The stomach is, as in the previous stage, a blind sac well filled with food. Its contents is even more thoroughly churned by more powerful contractions of the stomach walls. These contractions may start at either end running the length of the stomach, or starting at both ends run to the middle, or again starting in the middle run to both ends. The contents are at first the same yellow color as the scale, due to the fat globules swallowed, but later they become at first, due to digestion, a light orange, changing to dark orange and previous to being excreted a deep red to black color.

Feeding is carried on in the same manner as has been described for the first stage larva except that in the last part of this stage the mandibles, which are blunter and less curved than in the first stage, are used in destroying the internal organs and in scraping clean the inside of the skin of the scale.

The proctodæum is partially developed in the early part of this stage, but does not become fully developed or open until after the larva has consumed the entire contents of the scale and has entered a short quiescent period during which the contents of the stomach completes its digestive processes and is prepared to be excreted.

Following this period the waste, which has been accumulating in the stomach during the life of the two larval forms, is passed and is usually deposited along the lateral margins of the skin of the scale or at the ends. The chitinous portions of the proctodæum are passed out with the last of the waste and no doubt the chitinous portions of the fore-gut and tracheæ are also gotten rid of at this time.

The larva, following the passing of its waste, is usually found lying on its back with its head at the head end of the swollen skin which has dried and become a hardened case in which the parasite now pupates.

Pupation and the Pupa

Rapidly following the passing of the waste the larva usually begins to show differentiation into the three principal regions: namely, the head, thorax and abdomen. Following this condition, which externally marks the beginning of the pupal stage, pigmentation begins in the antennæ and its segments commence to form.

This coloration is quickly followed by that of the eyes, the dusky band of the fore-wings and a small portion of the ventral abdominal

plates. These last do not appear in any regular order. These areas continue to darken for the next few days and the surface of the pupa becomes wrinkled, indicating the formation of the legs, mouth-parts and sclerites. Following this the abdomen and other pigmented or darkened portions of the body rapidly darken and the pupa becomes nearly black.

Previous to emergence the antennæ, legs and mouth-parts become free and the last larval skin is kicked off and the now active insect soon starts cutting and gnawing its way out. There is considerable variability in the length of time it takes for the adult to emerge. Some very active ones emerge in about three hours while others take a day or more. In emerging, a hole is made through which the head is thrust and the insect then pulls and pushes itself out, working its body from side to side and forward and backward, all the time lifting and pushing with its legs.

After emerging the parasite walks a few steps and then cleans itself and straightens out its wings. The insect spends some time in this way and then starts crawling about and is ready for copulation.

Duration of the Life Cycle

The following data are based on rearings of parasites in the laboratory at room temperatures which averaged from 68° to 72°F.

In working out the length of the different stages of this life cycle it has been found that the variability in the length of the different stages indicates a very elastic life history, and one well suited for its life in the host. Hence, it is impossible to give more than average time lengths for the periods.

Examination of large numbers of scales, during the spring of 1914 at Amherst, shows that in general the scales survive the winter in two forms: first, that of well-grown, first-stage scales, which when parasitized contain eggs of the parasite; and, second, well-grown second-stage scales, which, when parasitized, contain well-grown first stage parasite larvæ.

It has been found by raising parasitized scales of the first stage that the parasites reached maturity in from thirty-six to thirty-nine days, while the parasites in the second stage scales matured in from nineteen to twenty-three days.

It is seen that the duration of the life cycle of those parasites raised from eggs compares favorably with that of the scale, thirty-three to forty days, as given by Marlatt. This is further supported by the observations of Dr. H. T. Fernald and the author that the scale in Massachusetts occurs in more or less distinct broods, and the examina-

tion of large numbers of parasitized scales indicates that the broods of the parasite coincide with those of the scale.

It has not been possible to work out the length of the egg and first larval stage, as while this work was in progress young scales were not available for experimentation; however, it was possible to work out the other stages, and these subtracted from the total leave an average of from fourteen to nineteen days for the egg and first larval stages combined. Again according to Marlatt the female scale molts for the second time on the average eighteen days from birth and observations made on non-parasitized and parasitized scales show that the majority of the first stage parasite larvæ molt at approximately the same time that the non-parasitized scales molt the second time.

The length of the second larval stage averages from six to eight days.

The waste passing period, which terminates the growth of the second larval stage and ends arbitrarily with the pigmentation of the antennæ, averages from one to two days.

The pupal stage averages from eleven to twelve days. Internal pupal development commences during the waste passing period.

Copulation

Sexual reproduction seems to be the rule as copulation has been observed to take place in hundreds of cases among insects that emerged both in the spring and fall. The percentage of males to females seems to be about equal, as of 463 insects selected at random as they emerged, 235 were males and 228 were females.

Copulation was found to take place as soon as the parasites had dried off after emergence and no doubt oviposition commences at once, for as stated earlier females previous to emergence contain developed eggs.

Males and females crawling about do not seem to locate each other from a distance by any apparent sense but more by accidentally coming very close or in actual contact. In such cases the male either pays no particular attention to the female or mounts her and is then either driven off or copulation takes place.

In copulation the male stands on the head and thorax of the female and rapidly pats and rubs her antennæ with his own and endeavors to draw the antennæ of the female to an erect position. The female may resist the male and drive him away; even in cases where copulation takes place the female usually resists at first, but occasionally not at all. When the antennæ of the female are raised to an erect position by the efforts of the male, assisted by the female, they are held behind and beneath those of the male and their tips are in con-

tact with the underside of the first and second basal segments of the flagellum of the male antennæ. The act of raising the antennæ seems to be that of assent, for copulation always follows this act. The male now shifts his position backward and grasping the abdomen and wings of the female with his fore and middle tarsi he leans backward and resting partially on his wing tips bends his abdomen between his hind legs which rest on the branch, and beneath the wing tips of the female and copulation takes place. Often a number of attempts are made before copulation finally takes place and this lasts from seven to sixteen seconds, the average length of time being from eight to eleven seconds.

During the act of copulation the female may stand quietly but usually walks, dragging the male with her.

After copulation takes place, the male again mounts the female and, drawing the antennæ of the female beneath and behind him as previously, the antennæ of the female having remained erect during copulation, usually stands quietly at first, occasionally moving his feet and gently patting her antennæ with his. Later he becomes restless and flits and fans his wings and finally leaves her, having stayed on her back from three to six minutes or more.

Polygamy and Polyandry

Emerging males and females were confined separately before copulation could take place and were then used to ascertain if the males would copulate more than once. A male and a female were confined together and copulation took place. The fertilized female was then removed and an unfertilized female substituted and the male readily copulated again, thus showing that they are polygamous.

The females that had been fertilized in the previous experiments were confined with males which had not copulated and these were under observation for two to three hours but copulation did not take place. Again often three or four males will attempt to copulate with one female and violent struggles take place among them, but in the cases observed only one male finally copulated with the female.

These last experiments indicate that polyandry is not, or is not the usual case.

Oviposition

The few cases of oviposition observed took place in young scales which had just formed a scale covering. In these cases the parasite crawled over the material on which she was placed until she found a young scale. This was examined by tapping it with the antennæ. She then turned back to the scale and thrust her ovipositor downward

and backward through the scale covering and into the scale until the tip of her abdomen almost touched the scale covering. While it was not possible to see the egg deposited in the scale it is evident that this takes place for, in the examination of first-stage scales, one finds the egg lying within the body.

The examination of mature first-stage scales, which are wintering over, shows eggs in all stages of development and even live larvæ may be found in the early stages of the second-stage scales as they are forming within the skin of the first-stage scales. From the large number of observations made upon first-stage wintering scales, which were brought into the laboratory to complete their development, it seems that the majority of the eggs hatch just as the second-stage scale is forming within the first-stage scale, although many hatch after the molt previous to the feeding period of the second-stage scale. Undeveloped and partially developed eggs have also been found in second-stage scales after feeding and growth have begun. These scales developed from first stage scales in the laboratory and hence it is seen that these eggs were laid late in the life of the first-stage scale. The above data indicate that oviposition takes place all through the life of the first-stage scale, after it has settled down, and that normally the majority of the eggs are laid early in the life of the young scale and these complete their development in mature second-stage scales, while those eggs which are deposited late in the life of the first-stage scale hatch so late in the life of the second-stage scale that it would not be damaged enough by the parasite to prevent it from passing into the third stage. This, it is seen, would account for the fact that some of the parasites emerge from early third-stage scales. However, there is a possibility of the parasite ovipositing in second-stage scales, but this seems unlikely as even its early life is additionally protected by the first exuviium and in its later life it seems even less likely due to its large size as compared with first-stage scales normally oviposited in.

Large numbers of the scales are oviposited in twice and possibly even more times, but twice is the most that has been observed. As a rule when two eggs are found in one scale they are widely separated in development, showing that they were laid at different times and hence by different individuals. In other cases one often finds an undeveloped or a partially developed egg and a live feeding larva in the same scale. Only two cases of like development have been observed; one was in which the two eggs found were at the same stage of development, and the other was in which the two larvæ were of approximately the same age. However, from the large number of observations made, it should not necessarily be taken that the same adult laid the two eggs in the scale, but rather that the scale in these cases was oviposited

in by a second parasite the same day that the first oviposition took place. These facts together with the fact that only one parasite matures in and emerges from a single scale certainly shows that normally this parasite is uni-oviparous.

In the cases where the hatching of the larva from the second egg deposited occurs long enough after the hatching of the first egg, so that the first larva has had time enough to nearly mature or to pass into its second stage before the second larva hatches or is able to seriously interferé with its feeding, then the second larva attacks the first and enters its body usually posteriorly and does not greatly injure the first larva at first, as the second larva has been observed many times within the body of the first, feeding on the stored granular substances of the older larva while it was still feeding on the scale. In the case of wintering over forms, which will be discussed later, and in cases which have been observed in the laboratory, the second smaller larva does not greatly injure the first larva until after it has passed its waste and then with the rapid development of the second larva (during its second larval stage) the first larva is consumed and the second then passes its waste, pupates and emerges.

Probably, in cases where the eggs laid are not separated by enough time for the above to take place, the hatching larvæ destroy each other, or, on the other extreme, the egg resulting from the second oviposition is destroyed before it hatches by the larva hatching from the first egg.

Large numbers of male second-stage scales were also examined for the eggs and larvæ of the parasite, but none were found. This seems rather strange as it does not seem possible that the parasite distinguishes between male and female first-stage scales. Owing to the comparatively small number of male second-stage scales found, it not being possible to distinguish male first-stage scales from the female scales, there being certainly far fewer males than females as compared with the statement given by C. L. Marlatt (Bull. 62, n. s., Bureau of Ent. U. S. Dept. of Agri., p. 43), that the malė scales comprise 95 per cent or more of those wintering over, the only suppositions then left are that oviposition in male first-stage scales results in their death or that in the material collected here at Amherst the males are actually much fewer and are not oviposited in.

Wintering over Stages

As stated previously the parasites pass the winter as undeveloped and partially developed eggs in the bodies of first- and second-stage scales. The first larval stage also winters over in the second-stage scales and also in the bodies of second-stage larval parasites, in the

latter case usually lying centrally within its body. These second-stage larvæ are not arrested in their development by the second parasite within them in such cases, until after they have completed their growth and passed their waste. In the spring these first-stage parasites continue their growth consuming the older second-stage parasite larvæ and after passing their waste pupate and emerge.

Older forms of the parasite such as the second-stage larva, pupa and adults have not been observed to winter over.

It will be readily seen from the above that dormant or winter spraying would not only kill the scale but also the parasite.

Distribution

This parasite has been reported from Massachusetts, Pennsylvania and the District of Columbia, and the examination of material received from Drs. E. P. Felt, P. J. Parrott and W. E. Britton, entomologists in the states of New York and Connecticut, show the parasite to be present in those states.

Length of Life of the Adult

It was noted that the adult parasite died on the average in two days, when confined in test tubes plugged with cotton. Previous to this time adults had been observed drinking or feeding on sap and also on the bodies of crushed scales, so an experiment was tried in which the insects were supplied with water. The parasites drank readily and lived on an average four days under this treatment. Honey water was also tried, but the parasites did not live longer than those given water.

Fungous Enemies

It has been noted that the same fungi which attacks the scales as readily attacked the larval and pupal stages of the parasite, also that a number of parasites confined in test tubes died from the attacks of a species of *Empusa*.

Predaceous Enemies

The predaceous enemies of the scale, as *Microweisia* (*Pentilia*) *misella*, are incidentally destructive to the parasite in all its stages of development except the adult stage. However, as yet predaceous enemies of the scale in nowise control it and thus there is little danger of the parasite being extensively destroyed even in newly planted colonies.

Parasite Enemies

No cases of true parasitism have been observed, but a type of parasitism does occur which may be termed incidental or accidental, as such external parasites as those belonging to the genus *Aphelinus*, which lie beneath the scale covering and suck out the entire contents of the second or third-stage San José scales; pupating between the scale covering and the empty skin of the scale and at the same time destroying the internal parasite as well.

Geotropism and Phototropism

The adult parasites show both positive geotropism and phototropism and these two reactions, together with the instinct of the parasite to search for scales, no doubt accounts for the fact that the scales on the smaller and outermost branches and twigs of infested material are well parasitized. This fact was also noted by H. E. Hodgkiss and P. J. Parrott (Jour. Econ. Ent., vol. VII, 227, April, 1914).

NOTES ON THE RICE WATER-WEEVIL (LISSORHOPTRUS SIMPLEX SAY)

By J. L. Webb, *Bureau of Entomology*

The amount of damage done yearly to the rice crop by the rice water-weevil is extremely hard to estimate. In most cases no rice is killed outright. On the other hand practically every rice field is infested to a greater or less degree. The effect of an attack is the pruning off of the roots near the base of the stalk. In severe attacks all the roots may be cut off, in others only a few. Where the pruning is not too severe, the rice plant promptly throws out new roots, continues to live, and will mature. Yet we do not know just how much has been lost in weight or quality of yield. The difficulty is in finding a field of rice entirely free from attack with which to compare infested fields. In extreme cases the rice plants are killed and the loss is then more easily estimated. In general, however, the loss from this source is considerable, and well worth active efforts in the way of prevention or elimination.

Seasonal History and Habits

According to the writer's observations the adult passes the winter in dead grass, especially grass that is matted down upon the ground. In order to find the weevils in hibernation the grass must be lifted up and thoroughly shaken out, allowing them to fall to the ground. Close examination of the débris is then necessary in order to distin-

guish the weevils, as their general color is much the same as that of the dry grass. Great numbers of weevils pass the winter in this way. Mr. C. E. Hood, one of the writer's predecessors in the study of the biology of this insect, records the finding of large numbers of hibernating weevils in Spanish moss. The writer believes Mr. Hood's observations to be correct, for from his own experience he has come to the conclusion that dead grass is the more favored place of hibernation.

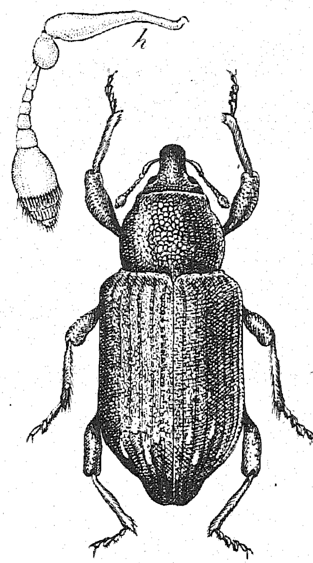


Fig. 23—*Lissorhoptrus simplex* adult enlarged, *h* antenna more enlarged (After Tucher)

Emergence from hibernation begins early and ends late in spring. The earliest date known to the writer upon which an adult has been observed to be active was March 25. The latest date upon which adults have been found in hibernation was June 26. This gives a period of three months for the emergence of the entire generation of hibernating individuals.

The adult weevils are usually not noticed in spring until the first flooding of the rice fields. Then almost immediately they are to be found swimming about in the water among the rice plants or resting upon the leaves above water. Sometimes they rest upon the leaves apparently for hours, but when touched promptly "play possum," fall to the water and swim away. They appear to be equally at home either in or out of water. However, it is impossible for them to breed in any but water plants.

Dissemination from hibernating quarters probably takes place mostly at night. The writer has never observed weevils in flight during the day. He has observed them quite frequently flying to lights at night.

The first injury to the rice plant occurs upon the leaves and is done by the adult weevils, probably both prior to, and succeeding oviposition. This injury takes the form of longitudinal feeding scars, the weevil eating out a longitudinal furrow in the leaf, just as broad as the spread of the mandibles. Only the thin epidermis is left where the feeding is done. Little real damage is done in this way, but the work is very characteristic of this species.

Copulation and egg laying apparently commence shortly after the adults reach the flooded fields of rice. When ready to deposit an egg the adult female crawls down the rice stem beneath the water and

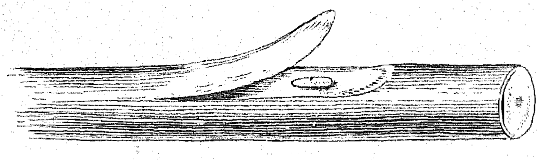


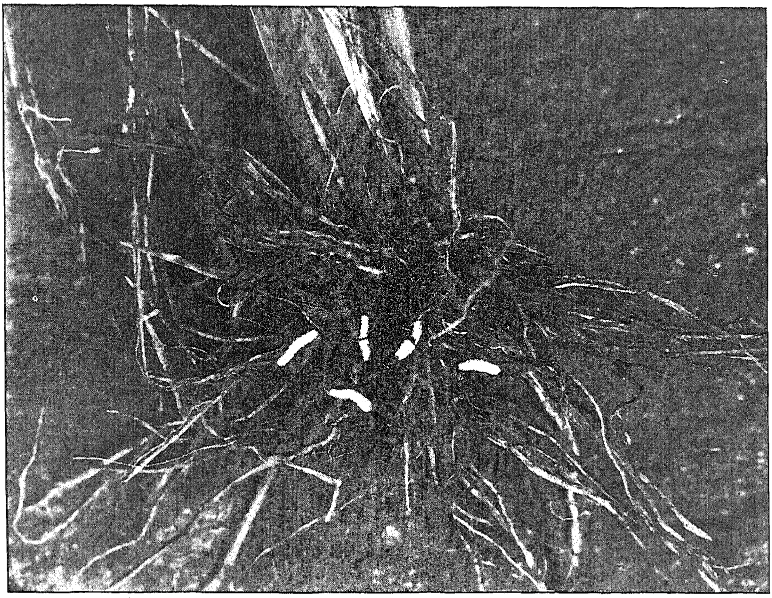
Fig. 24—Egg of Rice Water Weevil in section of rice root. The egg has been exposed by removing the epidermis of the root. Enlarged (original)

surface of dirt to one of the principal roots. Here she inserts the ovipositor, apparently by merely forcing the tip of this organ through the epidermis of the root. The egg (fig. 24) is then placed longitudinally just inside the epidermis. The egg is cylindrical, pearly white, and about one thirty-second of an inch in length. It is three or four times as long as broad and is barely visible to the naked eye. The writer, with the aid of a binocular microscope has found as many as three eggs laid end to end, apparently through the same hole in the epidermis. In other cases only one in a place was found. The microscope failed to reveal any evidence of the use of the mandibles in making the hole in the epidermis for the insertion of the ovipositor.

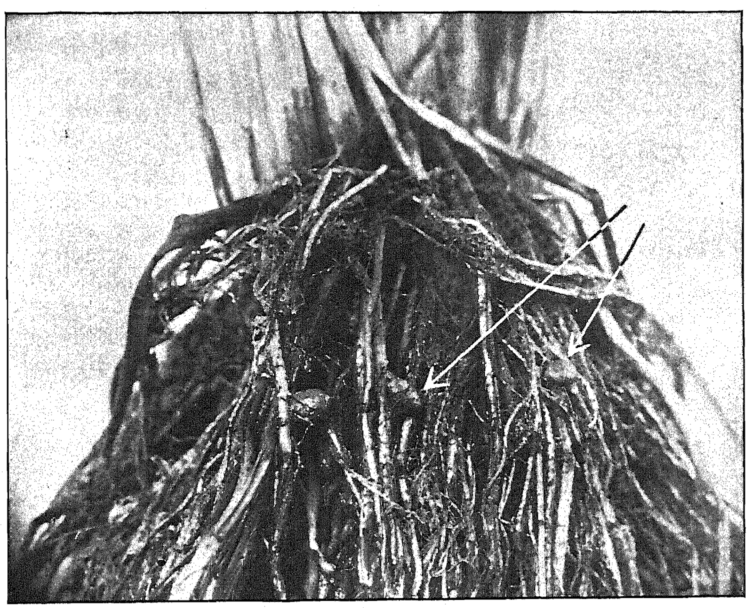
For the first few days of its existence the larva remains within the root in which it was hatched, feeding upon the inner root tissues and increasing in size. It advances along the root longitudinally, eating out a passageway as it goes. By the time it has exhausted the nutritive qualities of this first root, it is large enough to proceed farther and goes to another root undeterred by the surrounding mud. Whether it feeds little or much upon successive roots, practically all roots attacked are killed. Often several larvæ are found among the roots of a single plant (pl. 13) and work great destruction there. At this stage many of the larvæ are easily disclosed by pulling up infested rice plants and shaking the roots in water until washed clean of mud. Some larvæ always float on the surface of the water, while others sink to the bottom. When the roots of a rice plant are severely injured the leaves turn yellow, and according to Tucker[1] may even fall over upon the surface of the water.

When fullgrown, the larva is from one-fourth to one-half inch in length, very slender, and milk white. In preparation for the coming change, the larva gathers about itself an egg-shaped mass of dirt which it attaches to one of the healthy rice roots (pl. 13). The outside of this pupal cell is uniformly even and oval in shape. It would be interesting to know just how the larva accomplishes this result, but in the nature of things observations along this line were impossible. Within the pupal cell is a space from which water is excluded. Safe within this

[1] Bureau of Entomology Circ. No. 152, p. 8 (footnote).



Larvae of *L. simplex* on Rice Roots



2 Pupal Cases of *L. simplex* in Natural Position on Rice Roots

retreat, as if to make itself doubly secure, the larva spins a thin silken sac or cover about itself. The writer has found as many as fifteen pupal cells attached to the roots of one rice plant.

The pupa shows somewhat the form of the adult, but is entirely white like the larva. The duration of the pupal stage is probably from one to two weeks. When fully mature the adult breaks through the wall of the pupal cell, crawls up the root to which the pupal cell was attached, and so escapes to the open air.

The length of time the insect spends in each of these four stages is not definitely known. However, the time from deposition of the egg to the young adult stage in the spring has been approximately determined. In a plot of rice which was first flooded on June 1, 1912, the writer found a young adult in a pupa case on July 8, 1912. The egg could not have been deposited before the rice was flooded, and, supposing it to have been deposited the first day of flooding (June 1) the time occupied in reaching the adult stage by July 8, was thirty-eight days, or five and one-half weeks. It is, of course, possible that even less time than this was actually occupied by the insect in passing through the different stages.

Generations

Various cage tests and field observations, conducted by the writer, have shown that, under favorable conditions, at least a partial second generation of rice water-weevils in a season is possible.

On July 29, 1912, a pan of growing rice, known to be infested with larvæ hatched from eggs deposited by over-wintered adults, was placed in a cage. By the side of this pan within the cage a pan of uninfested rice was placed, the object being to determine whether or not, when young adults emerged from the infested rice, they would deposit eggs in the uninfested rice, and so start another generation the same year. On August 31, 1912, the roots of two or three rice plants in the last mentioned pan were washed out, revealing one medium-sized larva. On September 23, 1912, the roots of several more plants in this pan were washed out and six larvæ were found. The pan of old rice from the other end of cage was then removed, and, no weevils being observed in the cage, a small quantity of dead grass (previously shaken out) was placed there to provide hibernating quarters for any adults that might later emerge from the remaining pan of rice. On April 6, 1913, the dead grass was taken out of cage and carefully shaken out over a table. Eight living rice water-weevils and the remains of one dead one were thus disclosed.

Another cage test, practically a duplication of that just described,

yielded on March 22, 1913, eighteen living *Lissorhoptrus* adults and thirteen dead ones in the dead grass at bottom of cage.

The following account of a cage test to determine the number of generations of the rice water-weevil is copied verbatim from the notes of the writer:

"Crowley, La., July 22, 1912: A few days ago I emptied Cage No. 3, and placed therein a pan of young growing rice. Today I released thirteen young adult *Lissorhoptrus* reared from pupæ, in this pan. Also placed in bottom of cage some dry grass suitable for hibernating quarters, and hung a bunch of Spanish moss in the opposite end of the cage.

July 26, 1912—Placed two more reared adults in pan.
July 27, 1912—Placed one more adult in pan. This one taken from pupa case in field.
July 31, 1912—Placed one more reared adult in pan.
August 1, 1912—Placed one more young adult in pan.
August 2, 1912— " " " " " " "
August 3, 1912— " " " " " " "
August 5, 1912— " " " " " " "
August 6, 1912— " " " " " " "
August 8, 1912— " " " " " " "
August 9, 1912— " " " " " " "

"September 18, 1912—Pulled up all rice in pan and washed out roots in water. Only one small *Lissorhoptrus* larva found. Removed moss from cage and found two adult weevils in it. Removed dead grass from bottom of cage and found 114 weevils in it. Two weevils found in cage neither in moss nor grass."

From the foregoing it would appear that where a generation of weevils mature in early rice in the spring there is a possibility, and a strong probability, of a second generation in late rice. For example, near Rayne, La., on April 15, 1913, the writer found rice water-weevils active in a field of recently flooded rice. By June 1, young adults were probably produced in this field. At that time of year there was plenty of young rice recently flooded in which these young adults could deposit eggs for another generation.

The following field notes were made by the writer in the fall of 1912:

"Crowley, La., September 27, 1912: In a field of Japan rice, about a quarter of a mile east of the experiment station, I found today a few living larvæ of *L. simplex* and three pupæ. These probably belong to the second generation of the season. Larvæ and pupæ, however, were scarce. A large number of rice plants were pulled up to find the specimens just noted. The rice is headed out and apparently ripe enough to harvest. Field has been drained but water still stands in

low places. Most of the plants pulled up had roots severely pruned by *Lissorhoptrus*.

"Later in day found three or four *Lissorhoptrus* pupæ in a field of Japan rice about one and one-half miles south and a little west of experiment station. Field had been drained for cutting.

"Crowley, La., October 5, 1912: In same field (about one-fourth mile east of experiment station) in which I found larvæ and pupæ of *L. simplex* on September 27, I today washed out three living larvæ and one pupa of this species from Japan rice roots. Rice had been cut at this place, but the ground is still wet in places.

"Crowley, La., October 31, 1912: From rice roots pulled up yesterday in stubblefield, I today washed out a living *Lissorhoptrus* larva and one adult *Lissorhoptrus*."

The above observations show the latest fall records of the immature stages of this insect. Considering the period it takes for development from egg to adult—five or six weeks—there would be ample time during the spring, summer and fall for more than two generations. However, it does not appear probable to the writer that there are more than two generations per year.

In the fall the adults of the last generation go into hibernation for the winter in dead grass, as already described. The earliest date in the fall, upon which adults have been found in hibernation in the field by the writer, is September 30.

Hosts Plants

During the summer of 1912, the writer conducted a series of cage tests to determine in what native grasses the rice water-weevil would breed. Different species of grass were transplanted to flat bottomed, galvanized pans. The roots were well covered with dirt and the pans then filled with water. They were kept filled with water above the dirt during the tests. Two pans were used in each cage. Sometimes only one kind of a grass was used in a pan, sometimes more than one. After the water was placed in the pans adult rice water-weevils were captured in rice fields and about one hundred weevils placed in each pan. After allowing ample time for the weevils to lay eggs in the roots of the different grasses, and for these eggs to produce larvæ, the roots of each kind of grass were washed out in water to determine whether or not rice water-weevil larvæ were present. The following species of grasses were found to be infested by the rice water-weevil: *Echinochloa zelayensis* H. B. K., *Paspalum dissectum* L., *Paspalum boscianum* Flügge, *Syntherisma sanguinalis* (L) Dulac, *Capriola dactylon* (L) Ktze, *Axonopus compressus* (Sw) Beauv., *Panicum hiaus* Ell,

Panicum dichotomillorum Michx., *Jussiœa suffruticosa* L., *Eleocharis obtusa* Schult.

The following species were found to be not infested: *Paspalum dilatatum* Poir, *Commelina* sp., *Diodia virginiana* L., and *Eclipta alba* (L) Hassk.

The following species were found to be infested in the field: *Paspalum larrañagœ* Arech., *Paspalum plicatulum* Michx., and *Cyperus flavicornus* Michx.

Method of Control

Careful experiments have demonstrated that drainage is still the safest remedy for the rice water-weevil. The proper time to commence drainage of the fields is from two and one-half to three weeks after the first flooding, while the larvæ are still young. Drainage should continue for a period of two weeks. A shorter period of drainage will not kill the larvæ, and a longer period will injure the rice. Farmers should not wait until the rice begins to turn yellow before commencing to drain. The damage is practically all done by that time, and the rice needs water to enable it to throw out new roots and recover from the attack of the insect.

AGRILUS POLITUS SAY INFESTING ROSES

By Harry B. Weiss, *Assistant to State Entomologist, New Brunswick, N. J.*

During August, 1913, while inspecting nurseries in northern New Jersey in company with Mr. E. L. Dickerson of the New Jersey Department of Plant Pathology, our attention was called to the death of standard roses, the stems of which were swollen somewhat at different points. A number of infested stems were collected, some of which were sent to Dr. F. H. Chittenden. Under date of June 24, 1914, Dr. Chittenden wrote that adults had emerged and had been identified by Mr. E. A. Schwarz as *Agrilus politus* Say, heretofore recorded as being bred only from willow. Unfortunately only one specimen emerged from my galls and Mr. C. A. Frost[1] was of the opinion

[1] Since writing the above, Mr. Frost informs me that Mr. Chas. Kerremans of Belgium, to whom he sent my specimen, replied as follows: "I have examined your *Agrilus* very carefully; it seems to be a variety of the European *viridis* Linn. and it resembles very much the var. *fagi* Ratz. but is smaller. The elytral sculpture and the bronze copper coloration are the same; only the head is a little more irregular, the front being less smooth. It presents all the specific characters of *viridis* but *fagi* is not on the whole as copper colored as viridis."

Undoubtedly it will be necessary to obtain a larger series before the doubt in this matter can be cleared up.

that it was a European species. Dr. Chittenden mentions however, that as far as he knows no one has ever studied the foreign species of this genus in comparison with the native ones. Inasmuch as a considerable amount of the injury occurred on standard roses which had been imported from Holland in the spring of 1913, it was at first thought to be an imported species. However, Mr. H. M. Quanyes, of the Phytopathological Institute of Holland, to whom I sent photographs of the gall and a description of the injury, replied that no such insect work occurs in Holland on roses.

Nature of Injury: The work of the larva is characteristic of an Agrilus species and consists of a spiral band of channels in the sapwood, these channels being very close together for a distance of from three quarters of an inch to two and one half inches. After making these galleries, the larva goes up the stem in a zigzag fashion, sometimes just under the bark and other times irregularly through the pith and sapwood for a distance of from three to six inches where it constructs an overwintering larval chamber which serves for pupation in the spring, the adults emerging the early part of June. The swelling or gall on the stem occurs over the spiral band of channels and varies in size from being almost imperceptible to twice the diameter of the stem, depending, of course, on the size of the larva and its activity in making a spiral band.

On *Rosa rugosa*, these swellings were sometimes marked by longitudinal shallow splittings of the bark varying in length from one eighth of an inch to one inch. On stems not as woody as those of *rugosa*, the splittings were deeper and more open. As a rule, on *Rosa rugosa* only one gall was observed to a stem and it occurred anywhere from the ground up. In a few cases three or four were counted on a *rugosa* stem and five on a *carolina*.

The leaves of the infested roses first turn yellowish, finally withering completely and turning brown. The stem being weakened at the swelling breaks off easily. At one nursery in New Jersey, $200 worth of standard roses were destroyed because of this insect and at another it required the services of two men for over two days to cut and burn infested stock.

Varieties Infested: Standard roses as a rule are grafted on *rugosa* stock and *Rosa rugosa* seem to be particularly subject to attack. In addition the insect was found infesting *Rosa carolina*, *Rosa blanda*, *Rosa multiflora Japonica*, *Rosa rubrafolia*, *Rosa nitida*, *Rosa setigera* and wild roses.

Distribution: In New Jersey, infestations were found at Rutherford, Millburn, Springfield and Englewood. Mr. F. Windle, of West Chester, Pa., has noted injury to *Rosa rugosa* in that vicinity. Mr. H.

Hornig, of Philadelphia, has collected similar galls on wild roses at Bustleton, Pa., and Mr. E. L. Dickerson records them as occurring on wild roses at Nutley, N. J. Mr. Geo. G. Atwood of the New York Department of Agriculture writes that he has often seen abnormal swellings of rose stocks, particularly Manetti and multi-flora.

Considering the nature of the injury, it is evident that the cutting and burning of infested stems is the only method of control.

SOME COCCINELLID STATISTICS

By H. E. Ewing, *Oregon Agricultural College, Corvallis, Oregon*

In the western part of Oregon plant lice are very abundant and destructive. This is especially true in the Willamette Valley, where we find agriculture well advanced, the climate quite mild and vegetation luxurious. Among the various species found in the valley, few, if any, are more destructive than *Phorodon humuli* Schrank, the hop aphis; *Aphis brassicæ* Linn., the cabbage aphis; and *Aphis viburni* Scop., an aphid found on several garden and other plants.

We have in the valley also several well-known species of Coccinellidæ which usually do heroic work in checking the plant lice, but the writer has noticed the absence of a few species of these beneficial insects that are quite common in other sections of the country. Hence I decided to introduce some of these into this section of Oregon, and, as a preliminary step, have taken a few statistics on the relative numbers of the different species of coccinellids found feeding on the three species of aphids mentioned, and also feeding from the cell sap secreted by stipule glands of vetch plants. Data, which gives us some idea of the numbers of lady-birds present in any situation, and especially data which gives the ratios of the numbers of individuals of each species present and preying on any plant louse, are very serviceable in helping estimate the value of a species after it has once been introduced.

In order to get the population statistics we collected all adult beetles that were present in the following situations: feeding on *Phorodon humuli* Schrank, on hops; feeding on *Aphis viburni* Scop., on thistles; feeding on *Aphis viburni* Scop., on lamb's quarters; feeding on *Aphis brassicæ* Linn., on kale; and, lastly, feeding in vetch, chiefly from a cell sap secreted by special glands on the stipules of the leaves.

The collections from hops were made August 19, 1913. We collected all of the individuals found above our knees and up to as high as we could reach. Later counts showed that 209 individuals were captured. These were distributed among the different species as follows: *Hippo-*

damia spuria Leconte, 25; *Hippodamia convergens* Guér., 116; *Coccinella trifasciata* Cr., 12; *Coccinella transversoguttata* 1; *Cycloneda sanguinea* Linn., 53; *Adalia bipunctata* Linn., 2.

On August 19, 1913, collections were made of all the coccinellids found feeding on many thistles, upon *Aphis viburni* Scop. The total number of beetles found was 276. These were distributed as follows: *Hippodamia spuria* Leconte, 17; *Hippodamia convergens* Guér., 241; *Hippodamia parenthesis* Say, 2; *Coccinella 9-notata* Hbst., 7; *Coccinella trifasciata* Cr., 9.

On August 20, 1913, a large number of weeds, lamb's quarters, were examined and all adult lady-birds were collected. They were feeding on *Aphis viburni* Scop. In all 988 beetles were gathered. They belonged to six species, and in the following numbers: *Hippodamia spuria* Leconte, 30; *Hippodamia convergens* Guér., 913; *Hippodamia parenthesis* Say, 6; *Coccinella 9-notata* Hbst., 26; *Coccinella transversoguttata* Fald., 1; *Cycloneda sanguinea* Linn., 12.

In a kale patch feeding on *Aphis brassicæ* Linn., we collected 344 adult lady-birds. These represented all that were found on four rows of kale. The collections were made August 21, 1913. These different individuals were distributed among four species as follows: *Hippodamia spuria* Leconte, 28; *Hippodamia convergens* Guér., 314; *Hippodamia parenthesis* Say, 1; *Coccinella 9-notata* Hbst., 1.

Table Showing the Relative Abundance of the Different Species of Coccinellids for Five Different Situations in Percentage Terms of the Total Population Present

Situations	Relative Abundance Expressed in Percentages of Total Population Present							
	Hippodamia spuria	Hippodamia convergens	Hippodamia parenthesis	Coccinella 9-notata	Coccinella trifasciata	Coccinella transversoguttata	Cycloneda sanguinea	Adalia bipunctata
Feeding on *Phorodon humuli*, on hops ...	11.9	55.5	—	—	5.9	0.5	25.3	1.0
Feeding on *Aphis viburni*, on thistles ..	6.2	87.3	0.7	2.5	3.3	—	—	—
Feeding on *Aphis viburni*, on lamb's quarters.........	3.0	92.4	0.6	2.6	—	0.1	1.2	—
Feeding on *Aphis brassicæ*, on kale ..	8.1	91.3	0.3	0.3	—	—	—	—
Feeding on cell sap of vetch	8.69	87.05	—	2.69	1.26	—	0.31	—

The collections from the vetch fields were made June 4, 1913. We selected a strip of luxuriant vetch 240 feet long and six feet wide, and

collected all the adult beetles present. In our hunt we turned back and over the vetch plants in order to get the coccinellids from the lower leaves and the ground. This half-day hunt resulted in the capture of 633 lady-birds. The numbers of individuals of each species were as follows: *Hippodamia spuria* Leconte, 55; *Hippodamia convergens* Guér., 551; *Coccinella 9-notata* Hbst., 17; *Coccinella trifasciata* Cr., 8; *Cycloneda sanguinea* Linn., 2.

From these figures we get the following percentages of the total coccinellid populations for each species found in the different situations. They are given above in tabular form.

These percentages may be expressed graphically as I have done in Figs. 25 and 26. In Fig. 25 it is at once noted that *Hippodamia convergens* Guér. is by far the most common species, in fact the individuals of this species constitute a majority of the coccinellid population in each situation. Perhaps the next most striking feature noticed is the large number of individuals of *Cycloneda sanguinea* Linn., found feeding on the hop aphis. In the statistics for the other situations this species is quite rare, being absent entirely in the statistics for the cabbage aphis, on kale and from the counts for *Aphis viburni* Scop., on thistles. In four of the situations *Hippodamia spuria* Leconte is found to be second in numbers, as it doubtless is in importance. This is in accordance with a previous statement made by the writer (JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 6, p. 404), but without the authority of population statistics. With the exception of *Coccinella trifasciata* Cr., when found feeding on the hop aphis, no other species is found in such numbers as to equal or exceed 5 per cent of the total population for any environment. Hence these rarer species are of little value from an economic standpoint on account of their small numbers.

In Fig. 26, we notice that similar conditions prevail in the vetch field. *Hippodamia convergens* Guér. predominates to the extent of constituting over 87 per cent of the total population. *Hippodamia spuria* Leconte comes second, while *Cycloneda sanguinea* Linn., so common in the hop fields, constitutes only a little over .3 of 1 per cent of the total population.

In closing, I may add that the numbers of *Hippodamia spuria* Leconte, found in these situations as compared with those of *Hippodamia convergens* Guér., do not compare as favorably as they do in the statistics obtained from hibernating masses. Here *Hippodamia spuria* Leconte will frequently be found to be present to the extent of about one-half the number of *Hippodamia convergens* Guér.

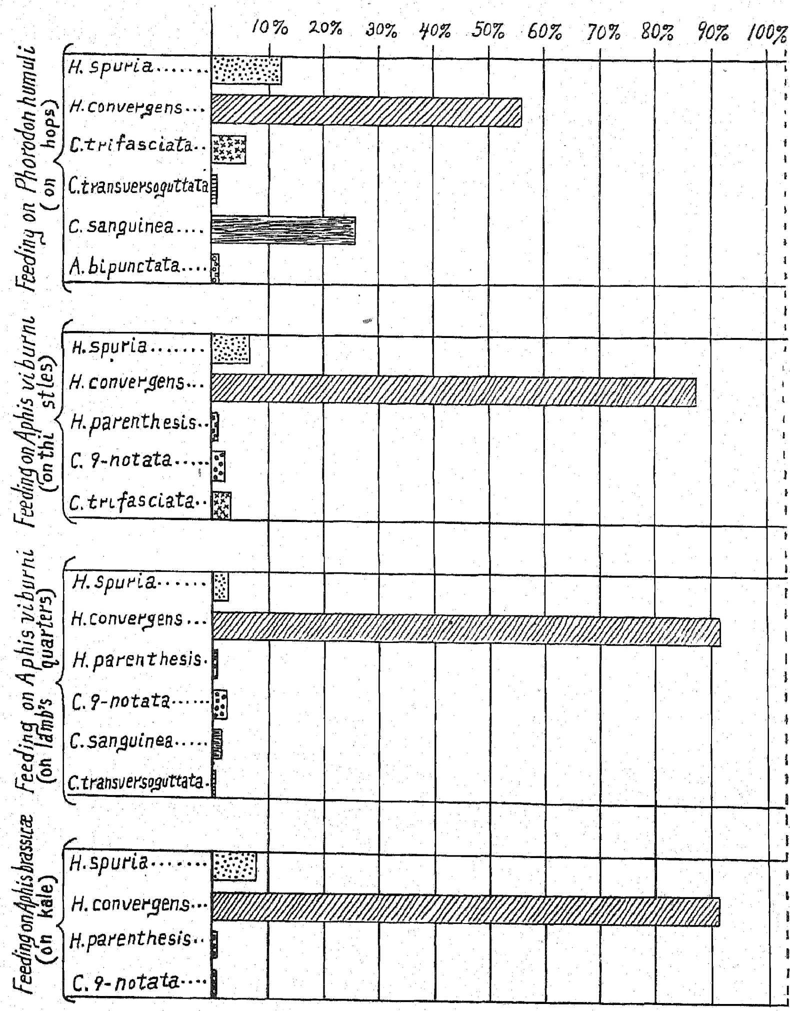


Fig. 25—Diagrams showing the relative numbers, expressed in percentage terms, of the total population of different species of Coccinellidae found in four situations

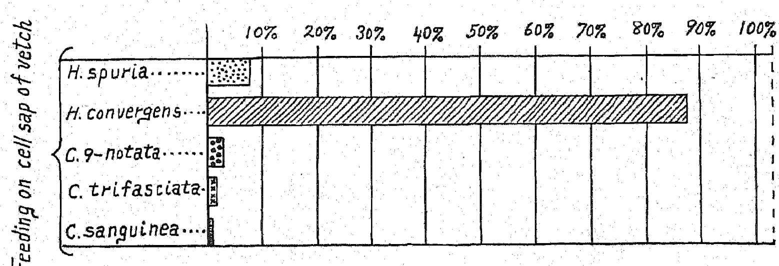


Fig. 26—Diagram showing the relative numbers, expressed in percentage terms, of the total population of different species of Coccinellidae found in each patch

A NEW PEST OF CANE IN FIJI (SPHENOPHORUS NEBULOSUS MACLEAY)

By J. F. Illingworth, Ph.D., *Professor of Entomology, College of Hawaii, Honolulu, T. H.*

This is a small beetle borer, similar in form to the ordinary cane borer (*Rhabdocnemis obscurus*). Though of smaller size it is exceedingly prolific; fortunately, for the present at least, it appears to do little damage to the sound cane. They deposit their eggs in any rupture in the stalk, hence they are very abundant in rat-eaten cane, or old stalks which are full of exit holes of the ordinary borer.

This beetle would prove a difficult pest to control if it ever became abundant enough so that it was compelled to attack sound cane. Its power of multiplication appears to greatly exceed that of the ordinary borer beetle. This fact was brought out during the breeding work of the Tachinid parasites, when the ordinary beetle borers were bred in large iron tanks, to obtain grubs for the flies. These tanks were filled with short cane stalks, and about two or three thousand of the adult beetles placed in each. Though we were careful to pick out all of the beetles of this smaller species, sometimes a few found their way in with the others. In such cases the smaller beetles produced so many eggs, in the souring cane, that their larvæ ate up most of the food from the larger species. In place of finding only one or two here and there in the stalk, as we do in the case of the larger grubs, these small larvæ were in dozens in each internode. They work along in parallel channels, side by side, and, unlike the large borers, never make rupture holes through the rind for air. Hence a parasitic fly, such as we have for the ordinary species, would have no chance to reach them.

It must be recognized that though the larger beetles were more than 100 to 1 of the smaller in the breeding tanks, referred to above, the conditions were not so favorable for their development. The larger species prefer fresh cane, though their grubs will continue to live in the stalks after they have become sour. A brief description of the several stages may help to recognize this new pest.

Larvæ. Numerous in parallel channels of injured or souring stalks; spindle-shaped, tapering gradually from about the middle towards the head and tail. Comparing them with the ordinary borer grub, the head is smaller in proportion; they lack the ventral enlargement of the fifth and sixth abdominal segments, and they usually remain straighter.

Pupæ. In cavities just within the rind of the stalk; without cocoon. This, and their small size will easily distinguish them from the ordinary borer.

ADULT. Small size, at least one-third less than the common species; reddish-brown when the beetles are newly emerged, becoming very dark-brown with age. The color is evenly distributed and lacks the darker spots that are found on *R. obscurus*. The feet lack the large pads, and the antennal knobs end rather obtusely.

The following description,[1] by William Macleay, from specimens collected in New Guinea, appears to agree for those in hand.

Sphenophorus nebulosus. Reddish-brown, opaque; rostrum thickened and scaly towards the head and with a fine stria along the whole of its length; the club of the antennæ very short and truncate.

The thorax is depressed and black on the median line. The elytra are strongly striate-punctate, the insterstices convex, the whole is indistinctly clouded with different shades of brown; the pygidium is rounded with four raised lines or costæ densely clothed with scales. The femora are unarmed. Length, 3 lines.

Mr. Frederick Muir of the Hawaiian Sugar Planter's Experiment Station, collected specimens of this species in New Guinea, Amboina and Larat.

REMEDIES. The best possible method of control that suggests itself would be to expose all rotten discarded cane to the sun for several days. This could be done either by first burning the trash, which would greatly assist in the destruction, or by having the cutters throw all discarded stalks out on top of the trash.

THE PROBABLE BEST METHOD OF REARING CERTAIN SCARABÆID LARVÆ[2]

By A. A. GIRAULT

These rough figures concerning three or four types of cages used by us in North Queensland for rearing to maturity scarabæid larvæ of root-feeding habit taken from cane fields and elsewhere, probably indicates the best type or types of cages, but the results are complicated by a number of factors which, so far, we have had to ignore. One of these factors is the relative hardiness or adaptability of the half dozen or so species concerned (*Lepidiota, Anoplognathus, Xylotrupes Callodes* and so forth). Here all species are taken as equal in this respect, which is very probably not so. Another complicating factor is the number of insects per cage, varying greatly from a hundred or more to three. In 1912, the average number per cage was about ten while

[1] Proc. Linn. Soc. N. S. Wales, 1887, 2d Ser., Vol. I., p. 192.

[2] Contribution No. 20, Bureau of Sugar Experiment Stations, Bundaberg, Queensland.

in 1913 it was about twenty-five. All of the cages were filled with sifted volcanic soil planted with corn; the larvæ were placed upon this soil and allowed to enter, in this manner selecting the most hardy, since the weaker ones were unable to enter and died upon the surface. The following types of cages were used: ordinary square wooden boxes (18 x 18 inches) kept in and out of doors; the same with wire gauze bottom and buried into the earth; ordinary red, earthenware flower pots kept indoors and wire gauze Tower breeding cages of various lengths buried in the earth for their entire depth. The tabulations are self explanatory, but maturities were counted if the pupa was successfully formed:

Year	Type of Cage	Total No. Larvæ	No. Maturing	Per Cent Maturing
1912........	Wooden boxes, indoors..................................	162	51	31.
	Flower pots, indoors..................................	58	18	32.
1913........	Wooden boxes, indoors..................................	1070	47	4.3
	Wooden boxes, outdoors..................................	1140	25	2.2
	Wooden boxes, miscellaneous..........................	3137	162	5.17
	Flower pots, indoors..................................	161	37	23.
	Tower cages, buried..................................	431	126	29.
	Wooden boxes, buried..................................	405	117	28.8
		6564	583	19.3

It is quite probable that the 1912 results are high because of the fewer cages (only thirty-five), thus not obtaining a true average, but it may be equally probable that they were due to the better attention which each kind of cage received. Thus it would seem that the kind of cage mattered very little, providing they received good attention. The two hundred and fifty or more cages of 1913 were not as well looked after, individually, as were the thirty-five of 1912. Yet, for our purpose, it was much better to use a large number of cages with smaller returns from each, since in 1912 only sixty-nine maturities resulted, whereas in 1913 over five hundred adults were obtained.

A hundred per cent of maturities resulted in two cases in flower pots with three and seven larvæ; in an ordinary box with forty-four larvæ of *Xylotrupes*, 77 per cent matured; with twelve cetonid larvæ in a flower pot 88.3 per cent matured; of twenty larvæ of *Anoplognathus*, 45 per cent matured in the ordinary box; of *Lepidiota* larvæ, the next largest percentage obtained from one cage was 68 with nineteen larvæ in a wooden box with gauze bottom, sunk into the earth. In two other cages of the same type and with the same species, 66 and 57 per cent of maturity were obtained with twenty-seven and twenty-six units respectively. But in a buried Tower gauze cage of a

depth of forty-three inches, with fifty-five larvæ, 72 per cent reached maturity.

It must be understood that the larvæ reared in these cages were usually a half or more grown before collected, usually remaining in the cages from two to five months before they were ready to pupate.

The best type of cage for this purpose seems to be the Tower cage sunk into the earth, but wooden boxes with gauze bottoms are perhaps equally as good and are much less expensive. Flower pots would be the third choice. Good drainage seems the essential factor from the standpoint of the cage.

THE SERPENTINE LEAF-MINER ON COTTON

By E. A. McGregor, *Bureau of Entomology*

In the course of the investigations of cotton insects at Batesburg, S. C., made by the writer[1] during the seasons of 1911, 1912 and 1913, a number of interesting notes have been made on the serpentine leaf-miner of cotton. The insect is a Dipteron, *Agromyza scutellata* Fallen, belonging to the family Agromyzidæ. A general account, under the name *A. pusilla*, was recently published by Webster and Parks. The present paper deals more particularly with the species as an enemy of cotton and is, therefore, supplementary to the recent paper by Webster and Parks in the *Journal of Agricultural Research*.

This species has been identified by Mr. W. R. Walton of the Bureau of Entomology and A. L. Melander of Washington Agricultural Experiment Station as *A. scutellata* Fallen, and by Mr. J. R. Malloch as *A. pusilla* Meigen. Mr. Melander considers *pusilla* a synonym of *scutellata* after making a thorough study of his own and Mr. Malloch's material.

The species is by no means peculiar to cotton. In the United States it has been bred from quite a number of different hosts, representing fourteen families of spermatophytes as shown in the accompanying table:

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[1] Both in the field observation and in the work incident to the breeding operations Mr. F. L. McDonough, of the Bureau of Entomology, was of substantial assistance to the writer.

TABLE I.—FAMILIES OF AMERICAN LEAF-MINER HOSTS

Family	No. of Hosts
Leguminoseæ	9
Cruciferæ	9
Compositeæ	4
Malvaceæ	3
Solanaceæ	3
Chenopodiaceæ	3
Curcurbitaceæ	1
Plantaginaceæ	1
Gramineæ	1
Fagaceæ	1
Hamamelidaceæ	1
Lobeliaceæ	1
Ranunculaceæ	1
Atripliceæ	1

During 1913 the leaf-miner was bred from seventeen host species at Batesburg, which is the greatest variety recorded for any one locality. This suggests that the species is decidedly omnivorous, but the preceding table reveals an apparent preference for the legume and the crucifer families. This might tend to show that *A. scutellata* formerly had for its regular host a species from one of these two families. The seventeen Batesburg hosts are given in the table below:

TABLE II.—LIST OF LEAF-MINER HOSTS OBSERVED AT BATESBURG, S. C.

Cotton (*Gossypium herbaceum*)	Lobelia (*Lobelia cardinalis*)
Mustard (*Brassica campestris*)	Oak seedling (*Quercus* sp.)
Nasturtium (*Tropæolum minus*)	Jerusalem-oak (*Chenopodium botrys*)
Cowpea (*Vigna unguiculata*)	Mare's-tail (*Lechea villosa*)
Cocklebur (*Xanthium canadense*)	Roman wormwood (*Ambrosia artemisiiflua*)
Corn (*Zea maiz*)	Sweet-gum (*Liquidamber styraciflua*)
Dahlia (*Dahlia variabilis*)	Sunflower (*Helianthus annuus*)
English aster (Aster sp.)	Woodbine (*Parthenocissus quinquefolia*)
Kudzu vine	

The host plants of *A. scutellata* in Europe have been listed by Webster and Parks.[1]

Doctor Chittenden has suggested the name "clover leaf-miner" to distinguish the species, but since other plants are equally attacked, it would seem preferable not to employ such a distinctive name. Webster and Parks, in a recent paper on this species on alfalfa,[2] propose the name "serpentine leaf-miner" which, to the present writer, seems more appropriate.

[1] Jour. Agr. Res., vol. I, pp. 59–87, Oct. 10, 1913.

[2] Webster and Parks. The Serpentine Leaf-miner. Jour. Agr. Res., vol. I, no. 1, Oct. 10, 1913.

The life history on cotton has not been determined in all details, but in a general way it is fairly well established as will be shown by the following notes:

Egg

The actual deposition of the egg has not been observed on cotton. On several occasions numerous adults of both sexes were liberated under control upon cotton leaves. On these occasions many puncture marks were made on the upper side of the leaves, but no oviposition was effected. These incisions resemble precisely the ovipositional punctures which are always to be found at the point of origin of the tunnel, and it is very probable that they are made to incite the exudation of sap for feeding purposes. Thus, unlike oviposition in alfalfa,[1] the leaf-miner invariably inserts her eggs on the upper surface of the cotton leaf.

In the case of cotton, the leaf-miner adult makes a very characteristic egg-puncture in the leaf (see fig. 27, a, b, and c). A hole is first rasped through the dorsal epidermis and then a small chamber is excavated in the underlying palisade tissue. The formation of this chamber causes the overlying epidermis to become countersunk, thus giving somewhat the appearance of a crater or drum-head (best shown in fig. 27, c). It is, doubtless, into the innermost recess of this chamber that the egg is inserted, since it is always from this point that the tunnel begins. Measurements of a considerable series of punctures yielded these averages: longest axis, .138 mm.; shortest axis, .0942 mm.

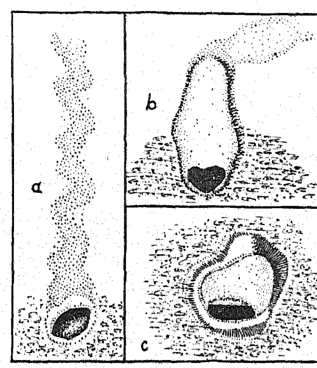


Fig. 27—a, b and c three ovipositional punctures by *Agromyza scutellata*, × 90

Larva

Upon hatching, the larva feeds almost exclusively upon the palisade tissue near the upper surface, and consequently it is there (plate 14, fig. 1) that the mine is formed. If the infested leaf is held between the eye and the sun the entire feeding operations can be seen. Holding to the tunnel walls by means of two curved hook appendages (see plate 14, fig. 3, for the remains of these organs in the pupa) the leaf tissue is rasped by the ceaseless activity of a remarkable black, radula-

[1] Webster and Parks. The Serpentine Leaf-miner. Jour. Agr. Res., vol. I, no. 1, Oct. 10, 1913.

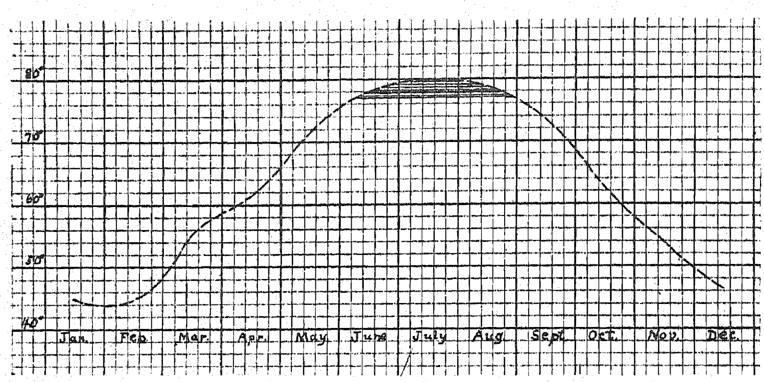


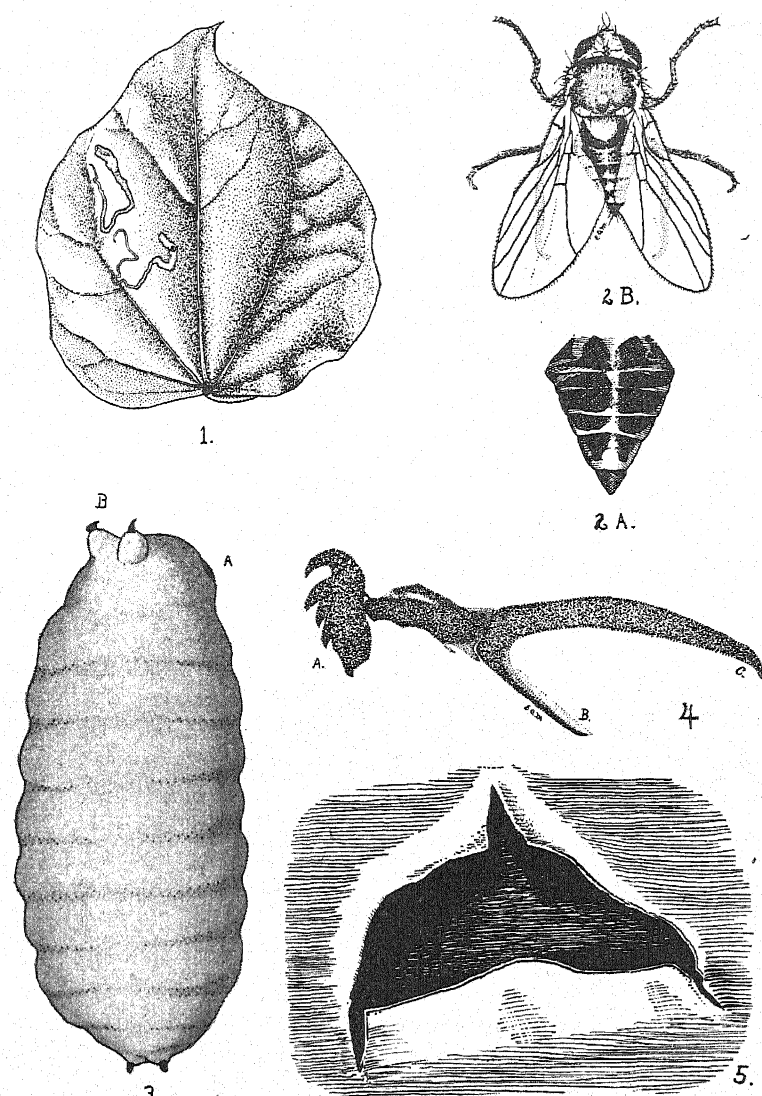
Fig. 28—Diagramatic curve illustrating the seasonal gradations of temperature at Batesburg, S. C., and the approximate zone of mid-summer aestivation (shaded)

like organ (mandible) which may be extruded or retracted at pleasure. This structure is swung, like a mower's scythe, backward and forward with an arching sweep of the oral region of the larva. This rasping organ becomes vestigial in the pupa, but still remains visible as a black, anterio-median ventral prominence (see plate 14, fig. 3 a).

The cephalo-pharyngeal skeleton (of which the rasping organ is a part) is Y-shaped in outline and consists of the usual three closely articulated sclerites. The base of the Y (the middle on hypostomal sclerite) is directed forward and is extended terminally into a somewhat semicircular plate (plate 14, fig. 4 a). This plate, the distal sclerite, bears on its outer surface five or more sharp recurved teeth. The hook-bearing plate lies normally exposed outside the mouth. The arms of the organ are of unequal size. The upper arm (plate 14, fig. 4 c) is much longer and broader than the lower and is somewhat geniculate; the lower arm (plate 14, fig. 4 b) is short, straight and narrow. The entire device is densely chitinized, the rasping, hook-bearing sclerite being especially opaque. A thin hyaline border occurs on the inner face of the inferior lateral plate. No parastomal sclerites occur in this species, but the hypostomal segment bears a heavily chitinized ridge or process which in position and appearance is at least analogous, if not homologous, to a weakly fused parastomal.

The pivotal center of the device appears to lie at some point along the hypostomal segment. Muscle bands extend from the distal ends of the Y-arms to the cuticular integument, and it is obviously the alternate contraction of these muscles which imparts action to the external plate.

Leaves frequently harbor several individuals and as many as a dozen well-formed mines have been counted in a single cotton leaf.



Seedling cotton leaf with two mines of *Agromyza scutellata* (natural size): fig. 2B.-adult fly × 28: A. abdomen from above (Semi-diagramatic, to represent dorsal markings): fig. 3–pupa, dorso-lateral view, A and B appendages of same, × 55: fig. 4–detail of oral appendage of larva,—A armed mandible, B lower branch of cephalo-pharyngeal skeleton, C upper branch of same, × 200: fig. 5–exit incision in upper epidermis of leaf made by mature larva, × 75. (Author's illustrations).

The tortuous courses of the burrows occasionally sever the veins of the leaves, causing the death of more or less of the leaf tissue. It rarely happens, however, that one tunnel intersects another.

As the grub increases in size the caliber of the burrow expands (plate 14, fig. 1) until full development is attained at its cavernous end. Having reached maturity, the larva deserts the leaf dorsally through a somewhat crescent-shaped incision (plate 14, fig. 5) near the large end of the mine. Measurements of a series of these exit holes averaged 1.00 mm. for the longest axis and .42 mm. for the shortest axis. The average dimensions of a number of mature larvæ in natural position (unextended) were 2.00 mm. long by .55 mm. thick. Since the act of egg-laying has never been witnessed by the writer, it is impossible to record with exactness the duration of the larval stage at Batesburg. However, a series of twenty-three larvæ collected in very new mines averaged about four days to pupation. Probably about one or two days had been spent by these larvæ in developing the mines to the point reached at the time of collection. This would fix the duration of the larval stage in cotton at Batesburg at about five or six days, which is somewhat greater than that established by Webster and Parks for this stage.

Pupa

In the great majority of cases observed, the mature larva, upon escaping, sought the soil at the base of the stock for pupation. Usually the larva buries itself very shallowly—not much more than covering itself. In a few cases pupation has occurred on the under surface of the leaf from which the individual emerged. These are marked exceptions, however. In no case have we ever known a miner to pupate within the mine. The puparium at first is a pale straw-color but as normal development takes place the color deepens to a golden-tan. In the case of parasitism the puparium changes in color to a smoky-brown.

A rather large series of measured pupæ averaged 1.62 mm. long by .72 mm. wide. Data is at hand covering development from the immature larva to adult for sixty-seven individuals. We find that for Batesburg, S. C., the pupal period for May, June and July ranges between six and twelve days as extremes. The weighted average for all individual cases gives 8.67 days as the normal pupal period for summer temperatures.

The fly issues from the puparium through a rupture at one end. The only adults actually observed in the act of emergence liberated themselves in the morning between the hours of 8 and 9 o'clock. As previously stated, several attempts have been made to induce oviposition under control. Potted cotton seedlings were placed

within specially constructed cheesecloth shelters. After sufficient exposure to the tender foliage, very careful examinations revealed numerous punctures exactly similar to ovipositional apertures, but no eggs had been deposited.

Seasonal History

The leaf-miner becomes noticeable in cotton leaves when the seedlings are but a few days old. Young larvæ were seen the present season (1913) as early as May 10. This was a late season, however, and it is probable that May 1 usually marks the initial appearance in cotton of the miner. From that date the infestation increases rapidly until by the middle of June almost complete infestation occurs. In the season of 1912 only one computation of infestation was made, namely, upon July 12, at which time 84 per cent of the plants were infested.

During the present season (1913) more complete data concerning infestation has been secured. From May 26, when an infestation of 41.5 per cent obtained, the occurrence rapidly increased until on June 19 an infestation of 98.7 per cent was computed. In fact it can be said that during May and early June the leaf-miner is the most common pest of the cotton plant in the vicinity of Batesburg, S. C.

It is interesting to record that the activity of the leaf-miner becomes markedly reduced toward the end of June in South Carolina. This is probably brought about through the agency of two factors, namely, parasitism and æstivation. Our observations at Batesburg relative to æstivation are quite in agreement with those recorded by Webster and Parks. Subsequent to the 20th of June, the formation of new mines in cotton was reduced to a minimum. During July and August abortive, unfinished tunnels are often seen, but long search is usually necessary before finding well-developed mines during these months. Furthermore, it was noticed that such abortive mines, when removed to the laboratory for breeding, rarely gave issue to adult miners. During these midsummer months, however, it was usually an easy matter to find well-developed mines and larvæ in leaves of *Lobelia cardinalis* growing in shaded woods, or in leaves of the floral nasturtium (*Tropaeolum minus*) and of the English aster (*Aster* sp.) growing in shaded portions of gardens. Since the larvæ in these environments must be equally accessible to parasitic attack, there must be some other factor or factors at work in the open fields which enforces this reduced activity. Through analogy with other species where æstivation has been demonstrated as a factor of natural control, it is undoubtedly true that midsummer temperature brings about a cessation of activity. The precise point where activity ceases and æstivation

begins has not been determined with accuracy. However, from a coördination of the most rapid development of the species with the prevailing temperatures, it becomes evident that the most favorable conditions exist between 65° and 75° Fahrenheit, also that the reduction of the species begins with a mean temperature of 77° Fahrenheit. (See fig. 29 for seasonal curve and zone of æstivation.) It has not been definitely established exactly how many generations develop in the season at Batesburg, but it is quite certain that three broods occur on cotton prior to the beginning of æstivation. Following the period of æstivation, development on cotton is discouraged greatly by the toughening of the leaves.

From the general economic standpoint the serpentine leaf-miner as Webster and Parks have stated, is primarily an enemy of forage crops. The loss to these forage crops is occasioned through the fact that the useful part of the plant is the foliage. However, it is doubtful whether any crop plants—including the clovers—exceed the cotton plant in degree of infestation. As above recorded, we observed cotton fields wherein 98.7 per cent of the plants were infested.

Since the fruit, rather than the foliage, is the portion of the cotton plant which is utilized, it is difficult to estimate the injury which is occasioned through the ravages of the leaf-miner. It is probable that the greatest damage occurs while the plant is very young, since a few mines at that time might greatly weaken the struggling seedling. In fact, the cotyledons and the earliest foliar leaves are often shed prematurely through the work of the pest.

Parasitism

In the course of the observations on the leaf-miner at Batesburg, it became evident as the season advanced that several species of parasites were at work. Only one computation of the degree of parasitism was made, which was as follows: total number of leaf-miner pupæ, 74; pupæ parasitized, 21; percentage of parasitism, 28.4. Parks found that at Salt Lake City, Utah, in September, 1911, 89.7 per cent of all Agromyza individuals were parasitized. It would seem, then, that natural enemies are much more of a factor of control in the alfalfa districts of the West than in cotton fields in the South.

Although no special attention was given to the rearing of leaf-miner parasites it develops that 7 Chalcidids, 2 Braconids, and 1 Dipteron—a total of 10 parasitic species—were bred during the investigations of 1913. As determined by Mr. J. C. Crawford, of the Bureau of Entomology, these are as follows: Chalcidids—*Zagrammosoma multilineata* Ashm., *Derostenus diastatæ* How., *Derostenus* 2 spp., *Pleurotropis* sp.; *Closterocerus* sp., *Chrysocharis* sp.; Braconids—*Opius* (2 spp.); Diptera—one species.

THE INTRODUCTION OF A TACHINID PARASITE OF THE SUGAR CANE WEEVIL BORER IN HAWAII

By Otto H. Swezey, *Honolulu, Hawaii*

The sugar cane weevil borer, *Rhabdocnemis* (*Sphenophorus*) *obscurus* (Boisd.), has long been a pest in Hawaiian cane fields. It probably became introduced along with shipments of "seed cane" from Australia early in the history of the sugar industry in Hawaii, and for several decades past has been generally distributed throughout the Islands, occurring in all of the plantations, and causing considerable loss of cane in many of them, often resulting in the destruction of half of the cane in fields especially favorably situated for them.

Various methods have been employed to check the ravages of the pest, with more or less beneficial results. After the remarkable success attending the introduction of the egg-parasites of the sugar cane leaf-hopper from Australia in 1904–05, it was decided to endeavor to find and introduce parasites for the borer pest also. Accordingly Mr. F. Muir was engaged by the Hawaiian Sugar Planters' Experiment Station to make a search for natural enemies of this weevil.

After considerable exploration of other sugar cane districts in search of the probable original home of the weevil cane borer and any parasites that it might have there, finally, at Amboina, in the East Indies, in 1908, Mr. Muir discovered a Tachinid fly [1] parasitizing a weevil infesting sago palms. The parasite was so effective that it was sometimes found to parasitize 90 per cent of the borers. As this borer was similar to the one in sugar cane in Hawaii (in fact, is to be considered only a local variation of the same species), it was thought that the introduction of this Tachinid to Hawaii should be attempted. In the summer of 1908, efforts were made to transport this Tachinid to Hawaii, by means of a relay breeding station at Hong Kong; but all attempts failed. The stages of the journey were too long for the transmission of the parasites in the pupal stage, and they would not survive cool storage.

Abandoning the transportation problem for the time being, Muir proceeded to British New Guinea for further investigations. Here he soon found the same Tachinid parasitizing a borer in sugar cane, which, on comparison, proved to be unmistakably identical with the borer in sugar cane in Hawaii. The Tachinid was found destroying a high percentage of the borers. Immediately plans were made for the transporation of the Tachinid to Hawaii. Mr. Muir found that he could breed the Tachinid on borers in cane in cages. Accordingly he

[1] *Ceromasia sphenophori* Villeneuve, Wiener Entomologische Zeitung, XXX, p. 81, 1911.

prepared cages to bring with him to Honolulu. Unfortunately he was taken down with typhoid fever on leaving Port Moresby, New Guinea, and on his arrival at Brisbane, Australia, was forced to abandon his voyage and go to a hospital. His parasite cages were sent on to Honolulu, but, lacking proper care en route, none of the parasites survived.

After several weeks in hospital, Muir recovered sufficiently to return to Honolulu, where after a short period of recuperation, he again undertook the introduction of this Tachinid from New Guinea. This attempt resulted successfully. It was accomplished by the use of relay breeding stations in the following manner. Mr. J. C. Kershaw, an entomologist whom Muir had met at Macao, China, was secured to assist in the undertaking. He and Muir met at Brisbane, Queensland, in January, 1910, to complete arrangements, by which it was planned that Kershaw prepare cages at Mossman, North Queensland, for breeding the Tachinids that Muir should collect and send him from New Guinea. Accordingly Muir proceeded to Port Moresby, New Guinea, and thence inland to the same place where he had previously found the Tachinid. There he collected puparia of the Tachinid and sent to Kershaw, the distance not being too great and the time involved short enough as to allow for their arrival at destination before the time for the emergence of the flies. When the latter emerged they were placed in the cages at Mossman already prepared by Kershaw with sugar canes containing numerous borer larvæ.

Muir continued sending puparia until Kershaw had the Tachinids satisfactorily breeding in his cages, when he joined him, and taking fresh puparia from the cages proceeded on to Fiji, where he established another breeding station. When this was successfully started and the Tachinids breeding satisfactorily, Kershaw abandoned the cages in Queensland, taking with him to Fiji more puparia of the Tachinid. On his arrival, Muir came on to Honolulu with a supply of Tachinid puparia, leaving Kershaw in charge of the breeding cages in Fiji, where he remained a few more weeks and then came on to Honolulu with additional supplies of the parasites.

Mr. Muir arrived in Honolulu with living parasites in August, 1910, and Kershaw arrived the following month. A part of the parasites they brought were liberated in cane fields where there was an abundance of borer larvæ in the cane in which they could breed, and part were retained for breeding in cages at the Experiment Station. The breeding in cages was soon going satisfactorily and was continued for two years, colonies of the parasites being liberated on the various sugar plantations as rapidly as they were available. They bred continuously, each generation requiring about six weeks, so that there were about eight generations per year.

After about six months the Tachinids were found established and increasing in those plantations where the first liberations were made; and in the course of about a year they were spread to all parts of these plantations, in some instances covering an area five miles or more across.

Now, after three years, they are established almost entirely throughout the sugar cane districts of the Islands. In those plantations where the borers previously caused the greatest loss of cane, little damage is now occasioned, and there has been a saving of many thousands of dollars to them. An indication of the beneficial reduction of the borers by this Tachinid may be gained by these comparative figures from one of the larger plantations where they have for a number of years practiced the collection of the adult borers from the cane fields. The past year 3,440 ounces of these beetles were brought in by the collectors; whereas, the previous year 27,010 ounces were collected, a reduction of over 87 per cent. Hardly an injured cane was to be found in some fields harvested this year, of the same plantation, where formerly a great deal of cane was lost by borers.

In another plantation formerly suffering severely from borer attack, there was a reduction of 44 per cent in the amount of damaged cane in the crop harvested the second year after the establishment of the Tachinid. In most places, examination shows a parasitization of from 50 to 80 per cent. Oftentimes it is difficult to find a borer that is not parasitized.

The method of attacking its host is quite unique in this Tachinid. The adult female deposits her eggs at openings in the rind of the cane where the borer larvæ feeding inside have come to the surface and made tiny holes. Frequently small maggots are deposited instead of eggs. The maggots search out the borer larvæ in the channels where they are feeding, penetrate the body and feed upon the juices and fat, eventually killing the host when it is about ready to pupate after having constructed its cocoon of wound-up cane fibers. From one to a dozen maggots may thrive in one borer larva, one, however, is sufficient to kill the latter. Having become full-grown, the maggots emerge from the empty skin of the host and form their puparia within its fibrous cocoon. Two weeks are spent in the pupal stage, and when the adult flies emerge they make their way out of the cocoon and from the cane through the hole which the borer larva, before constructing its cocoon, has instinctively made to allow for the escape of the adult borer when matured.

This is only a very brief account, but full details of the discovery, introduction, establishment and life history of this Tachinid will be given in a forthcoming Bulletin from the Hawaiian Sugar Planters' Experiment Station.

LIST OF ZOOPHAGOUS ITONIDIDAE

By E. P. Felt, *Albany, N. Y.*

The following records show that a considerable number of gall midges are predaceous and that this habit appears among widely separated groups. The list of 29 species is far from complete, since we have made no attempt to include therein, species which doubtless prey upon other gall midges, a habit typical of Lestodiplosis and probably other genera.

Table of Reared Species

Predator	Host
Coccidomyia pennsylvanica	Lecanium on beech
C. erii	Erium lichtensioides
Dentifibula cocci	Aspidiotus uvæ
Endaphis americana	Eriophyes on ash
Dicrodiplosis coccidarum	Orthezia and Dactylopius
D. californica	Pseudococcus
D. antennata	Phenacoccus
Mycodiplosis pulvinariæ	Pulvinaria
M. insularis	Tetranychus (red spider)
M. acarivora	Red spider on lemon
Aphidoletes marina	Aphis gossypii
A. cucumeris	Aphis gossypii
A. borealis	Aphid on tulip leaves
A. meridionalis	Siphonophora liriodendri
A. basalis	Aphids on Tanacetum (tansy)
Diadiplosis cocci	Saissetia nigra
Karschomyia cocci	Pseudococcus sacchari
Lobodiplosis coccidarum	Orthezia and Dactylopius
Arthrocnodax abdominalis	Red spider
A. occidentalis	Red spider
A. carolina	Red spider
A. apiphila	Beehive infested by mites
A. meridionalis	Eriophyes
Lestodiplosis grassator	Phylloxera galls
L. peruvina	Hemichionaspis minor
Lestodiplosis species	Aleyrodes
Itonida aphidivora	Aphis malifoliæ
Cecidomyia coccidarum	Orthezia and Dactylopius
Cecidomyia species	Cicada eggs

Summarizing the above we find that the scale insects or Coccidæ are preyed upon by the following nine genera: Coccidomyia, 2 species; Dentifibula, 1 species; Dicrodiplosis, 3 species; Mycodiplosis, 1 species; Diadiplosis, 1 species; Karschomyia, 1 species; Lobodiplosis, 1 species; Lestodiplosis, 2 species, and Cecidomyia, 1 species.

The plantlice or Aphididæ are attacked by Aphidoletes, 5 species; Lestodiplosis, 1 species, and Itonida, 1 species, the first genus evidently displaying a marked partiality for the Aphididæ.

Tetranychus or red spider is preyed upon by 4 species of Arthrocnodax and 1 of Mycodiplosis. It will be seen by referring to the above tabulation, that Arthrocnodax displays a marked partiality for the Acarina.

The plant mites or Eriophyidæ are preyed upon by 1 species of Endaphis and 1 of Arthrocnodax.

A species of gall midge, genus unknown, has been reared or was supposed to have been reared from the eggs of the periodical Cicada, *Tibicen septemdecim.*

It appears very probable from the above records, particularly in connection with the observations of Mr. E. A. MacGregor upon *Arthrocnodax carolina*, that the value of certain gall midges as natural enemies has been largely overlooked. There are probably a considerable number of other species, presumably mostly undescribed, which have similar habits.

ON THE ORIGINAL HABITAT OF STOMOXYS CALCITRANS

By F. Muir, *Taihoku, Japan*

In his interesting article on the geographical distribution of the stable fly,[1] Prof. C. T. Brues writes that "it is probably a native of the old world, most likely of central Europe," and, near the end, "It is probably native to the palæarctic region from whence it has followed man in his migrations to all parts of the world."

I am not able to follow Mr. Brues in these conclusions, and as they are of some importance in economic entomology, when endeavoring to discover parasites to control this pest, I would like to state my reasons for differing from an authority who has given this species a great deal of study.

In judging of the native habitat of a widely distributed insect like *S. calcitrans*, there are two points that I consider necessary to take into consideration: (1) the center of activity of the genus as indicated by the geographical distribution of the species of the genus; (2) the number and specialization of the natural enemies of the species under consideration, and its relative abundance in the different regions.

Turning to Brues' list of species of *Stomoxys*, and, if we leave out of consideration *calcitrans*, which is world wide, *nebulosa*, which is doubtful, and *pallida*, which is without given habitat, we have twenty-eight species, all of which belong to the Oriental and Ethiopian regions. Nine are native to India and Ceylon, and two a little to the east; fourteen to the African mainland and three to neighboring islands.

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[1] Jour. Econ. Ent., Vol. 6, No. 6, 1913, pp. 459–477.

From this it appears that the center of activity of this genus is within the Indo-Ethiopian region, and, therefore, *calcitrans* is more likely to have arisen within this region than independently within the *palæarctic*.

Little is known of the parasites of this insect, especially in the Ethiopian region, but from my own observations in various parts of Africa I should say that it is less abundant there than in many extra-tropical places I have collected in. Seeing that the climatic conditions in Africa are more favorable than in temperate climates, the less abundance of this insect there may possibly be due to the presence of parasites.

Whether India or Africa was the birthplace of this species, it is difficult to judge, as there is no evidence to judge by, but my personal belief, unsupported by any direct evidence, is that the honor (or dishonor) should be given to Africa.

A NEW CECIDOMYIID FLY

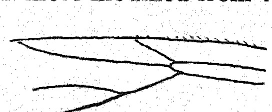
By T. D. A. Cockerell, *Boulder, Colorado*

On July 15, 1913, I observed a large number of small gnats hovering over flowers of Japanese *Iris*, in the grounds of Mr. D. M. Andrews, about three miles east of Boulder, Col. These prove, on examination, to represent a new species of the interesting genus *Microcerata* Felt.

Microcerata iridis n. sp.

Male. Length nearly 2 mm.; reddish brown, with the legs cream-color; thorax redder than abdomen, the latter dilute sepia; wings clear hyaline with very pale veins; antennæ 9 jointed, the last three joints more slender than those before; palpi 4 jointed, the last joint very long. Very close to *M. spinosa* Felt, with the antennæ and palpi practically as in that species; but distinguished by the much larger size, pallid legs, subcosta joining costa before middle of wing; basal segment of clasp of genitalia swollen apically, terminal segment subbulbous basally and sharply bent apically, style as long as first segment of clasp. The following measurements are in microns: width of second antennal joint, 51; width of third, 37; width of ninth, 16; length of last palpal joint, 82; length of last segment of clasp, 75.

This is quite close to the fossil *Lithomyza* Scudder, but has the venation more modified from the supposedly primitive type.



a

b

Fig. 29—Portion of venation;
a *Microcerata iridis*, b *Lithomyza condita* (latter after Scudder)

ADDITIONAL NOTES ON PORTO RICAN SUGAR-CANE INSECTS

By THOMAS H. JONES, *Entomologist, Board of Commissioners of Agriculture of Porto Rico*

In the first three annual reports of the Experiment Station of the Sugar Producers' Association of Porto Rico, Mr. D. L. Van Dine, formerly Entomologist, published notes on the sugar-cane insects of the island. In the third annual report Mr. Van Dine gave a list of the insects affecting sugar cane in Porto Rico, including therein mention of their natural enemies, followed by a bibliography of Porto Rican sugar-cane insects. On pages 251 to 257 of the JOURNAL OF ECONOMIC ENTOMOLOGY, Vol. 6, No. 2, there also appeared in 1913 an article written by Mr. Van Dine, entitled, "The Insects Affecting Sugar Cane in Porto Rico." No annual report of the Station will be published this year and, as it is possible to present a few additional notes, the following supplementary information is here given for the benefit of economic workers, especially those interested in sugar-cane insects.

During the past year Mr. E. E. Green, the well known authority on *Coccidæ*, has advised us that, after examining specimens of sugar-cane mealy-bugs that were sent him from Rio Piedras, he finds that they "agree exactly with examples of *Pseudococcus calceolariæ* Mask," his determination being based "upon comparison with typical examples received from the late Mr. Maskell himself." Apparently this mealy-bug has not before been recorded as occurring in Porto Rico, all previous references to sugar-cane mealy-bugs being given under the name of *Pseudococcus sacchari* Ckll., which was first recorded from the island in a list of *Coccidæ* collected by Mr. August Busck during 1899. In connection with this list, which appeared in Bulletin No. 22, new series, of the United States Bureau of Entomology, it is stated that the determinations were made by Messrs. T. Pergande, T. D. A. Cockerell, and C. L. Marlatt. The material representing *Pseudococcus sacchari* was therefore probably examined by the author of the species.

On January 30, 1913, at Patillas, Mr. Van Dine found larvæ of a cecidomyiid in colonies of sugar-cane mealy-bugs, *Pseudococcus sacchari* (?). From these, adults were reared and specimens were forwarded to Dr. L. O. Howard, Chief of the United States Bureau of Entomology, who referred the specimens to Dr. E. P. Felt of the New York State Museum. Dr. Felt identified them as belonging to a new species which he has described as *Karschomyia cocci*.[1] In a letter,

[1] *Canadian Entomologist*, Vol. XLV, No. 9. Sept., 1913. pp. 304–305.

written subsequent to the publication of the description, Dr. Felt writes that "*Karschomyia cocci* belongs with a considerable series known to be predaceous, and there is very little question but what this insect is an enemy of the sugar-cane mealy-bug, . . . "

One new enemy of *Laphygma frugiperda* S. and A. has been observed. This is the common predaceous Reduviid bug, *Zelus rubidus*, which has been found attacking the *Laphygma* larvæ.

Mr. W. R. Walton of the United States Bureau of Entomology has described two new *Tachinidæ*, reared from Noctuid larvæ that feed upon the leaves of sugar cane. One of these, *Linnæmyia fulvicauda*, is parasitic upon *Remigia repanda* Fabr., the other, *Compsilura oppugnator*, upon *Cirphis latiuscula* H. S.[1]

The determination of an Hesperid, *Prenes ares* Felder, bred from larvæ found feeding on cane leaves, has been received from Dr. H. G. Dyar of the United States Bureau of Entomology. The larvæ of still another Hesperid have been observed upon cane foliage and Dr. Dyar states that this species "comes near *Thymelicus magdalis* H. S. from Cuba, but is obviously distinct." These Hesperids, together with the species already recorded, *Prenes nero* Fabr., are unimportant as pests of sugar cane in Porto Rico.

Two plant-lice are known to attack sugar cane in Porto Rico. One of these has previously been recorded from the island under the name of *Sipha graminis* Klt.[2]

More recently, material has been examined by Mr. J. T. Monell and Mr. John J. Davis of the United States Bureau of Entomology and they have determined the species as *Sipha flava* Forbes. The second species which has been referred to by Mr. Van Dine as "another species of aphis . . . . at present undetermined,"[3] has been identified by Mr. Davis as *Aphis setariæ* Thos. The Chrysopid which feeds upon *Sipha flava* has been identified by Mr. Nathan Banks of the United States Bureau of Entomology as *Chrysopa collaris* Schm. *Aphis setariæ* is heavily parasitized by what Mr. A. B. Gahan of the United States Bureau of Entomology states is probably *Lysiphlebus testaceipes* Cress. The larvæ of a ladybird, *Scymnus roseicollis* Muls., have also been observed feeding upon it.

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[1] Proceedings of the Entomological Society of Washington, Vol. XVI, No. 2. June, 1914. pp. 93–95.

[2] Hooker, C. W. Entomological Conferences in Porto Rico. JOURN. ECON. ENTOM., Vol. 6, No. 1, pp. 148–150. p. 149.

Van Dine, D. L. The Insects Affecting Sugar Cane in Porto Rico. JOURN. ECON. ENTOM., Vol. 6, No. 2, pp. 251–257.

Van Dine, D. L. Report of the Entomologist. Bul. 5 (3d Ann. Rpt.), Exp. Sta. of P. R. Sugar Producers' Assoc., August, 1913, pp. 25–46, pp. 32–33.

[3] Bul. 5 (3d Ann. Rpt.), Exp. Sta. of P. R. Sugar Producers' Assoc. p. 40.

Mr. A. A. Girault of Australia has reported that the Mymarid egg-parasite of *Delphax saccharivora* Westw. which occurs in Porto Rico is *Anagris armatus* (Ashmead).

At Rio Piedras during January, 1914, two species of thrips were taken from cane leaves on which characteristic thrips injury was noted. These were referred to Mr. J. D. Hood of the United States Bureau of Biological Survey, who has described one species as new to science, under the name *Haplothrips* (?) *tibialis*. The other species *Heliothrips femoralis* Reuter, represented by a single female, is, according to Mr. Hood, an abundant and destructive pest in the greenhouses of Finland, Sweden, Belgium, England, Italy, and the United States, its native home being open to conjecture.[1]

The mite which feeds upon the stalks of sugar cane, beneath the leaf-sheaths, Mr. Banks has identified as *Tarsonemus spinipes* Hirst. Although it was not described until 1912, this mite has been known to attack sugar cane in the West Indies for many years. Mr. W. Nowell, now Mycologist of the Imperial Department of Agriculture for the West Indies, well describes the injury it produces, as follows: "Causes small red blisters on the surface of the young internodes of sugar cane while still in the sheathing canes, which are also to some extent affected. Results in a reddish-brown corroded appearance of the surface of the cane, especially a streak above the eye."[2].

The mite which has been found working on the leaves of sugar cane Mr. Banks pronounces to be a species of *Tetranychus*, perhaps new.

ON THE VALUATION OF LIME-SULFUR AS AN INSECTICIDE[3]

By Herman V. Tartar, *Corvallis, Ore.*

At the present time, the object of the examinations made of samples of commercial lime-sulfur solution, in different chemical laboratories throughout the country, is to ascertain data regarding composition. In many cases, simply the total lime content, total sulfur content, and specific gravity are ascertained. Oftentimes, however, quantitive determinations are also made of the different forms of sulfur in combination. Entomologists and horticulturists, making field experiments, generally use a gravity test only.

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[1] *Insecutor Inscitiæ Menstruus*, Vol. II, No. 3, 1914. pp. 38–41.

[2] *Bulletin of Entomological Research* (London), Vol. III, Pt. 3, Nov., 1912. p. 328.

[3] Contribution from the Chemical Laboratory of the Oregon Agricultural Experiment Station.

A large proportion of the lime-sulfur used is for insecticidal purposes. Consequently, examinations made in the valuation of the same should be quantitative determinations of those properties from which the spray derives its insecticidal value. Actual chemical composition is a secondary matter except in so far as it may be an indication or measurement of these properties. For this reason, the determination of specific gravity is perhaps of little value except in a very general way. Samples of lime-sulpur having the same specific gravity may not be alike in chemical composition nor in many other properties. For example, a sample having a low specific gravity may have a greater per cent of polysulfides than a sample having a somewhat higher specific gravity.

In this discussion of valuation, it is well first to consider the properties which give to lime-sulfur its insecticidal value. The most exhaustive investigation available is, perhaps, that of Shafer.[1] He showed that with scale insects, like San José scale, the calcium polysulfides present in the solution softens the so-called wax about the margin of the insect and, on drying, causes it to stick to the plant. In the cases tried, the insects stuck tightly enough to also cause the death of the young by sealing them under the scale covering of the mother. Shafer's work also strongly indicated that one of the principal, if not the principal, insecticidal effect of lime-sulfur solution, upon insects of the type mentioned, is its great power of absorbing oxygen, thus causing the treated insects to suffer because of an insufficient supply of this element. Other experiments made by Shafer showed that sulfur dioxide is not "formed in appreciable amounts from sulfur deposited by lime-sulfur except at temperatures much above those found under spraying conditions in the orchard." The liberation of this gas is, evidently, not in amounts large enough to make it of importance in any consideration of the insecticidal properties of the spray. The work done by the department of entomology of this station[2] indicates clearly that the principal insecticidal constituents are the calcium polysulfides. Experiments tried with calcium thiosulfate on San José scale [3] showed this material to have but little, if any insecticidal value. Wellington [4] arrived at similar conclusions. Shafer's[5] results also indicated that the thiosulfate has a limited insecticidal efficiency.

It has been known for long, too, that with certain insects, free sulfur has some killing power. It is stated that dry sulfur has been used in

[1] Tech. Bul. No. II, Mich. Agr. Exp. Sta.
[2] Unpublished results.
[3] Biennial Crop Pest and Horticultural Report, p. 112 (1913).
[4] Bull. 116, Mass. Agr. Exp. Sta.
[5] Loc. cit.

California perhaps a quarter of a century against almond red spider. The experimental work carried on by the experts of the California Agricultural Experiment Station[1] and the Bureau of Entomology, United States Department of Agriculture[2] shows that towards certain insects free sulfur has marked insecticidal properties.

There is also the possibility that hydrogen sulfide, a gas poisonous to insects, may be liberated from lime-sulfur when it combines with the carbon dioxide of the atmosphere or that given off in the breath of insects. So far as the writer knows, no means has been found to ascertain the extent to which this occurs. Experimental work carried out at this laboratory, however, indicates that if hydrogen sulfide is liberated under normal conditions it is in very small quantity, and, evidently, is not an important matter to consider here.

From the discussion preceding, it appears that, in general, the insecticidal properties of lime-sulphur are due principally to the following-named properties:

(1) Its power to take up large amounts of oxygen, (2) its ability to soften the newly secreted wax at the margin of scale insects, and (3) the amount of free sulfur formed in its decomposition. If this be true, then the question of the correct valuation resolves itself into the quantitative measurement of these factors.

The amount of oxygen consumed depends upon reactions as represented in the following equations:

$$\begin{aligned} CaS_5 + 3\,O &= CaS_2O_3 + 3\,S \\ CaS_4 + 3\,O &= CaS_2O_3 + 2\,S \\ CaS_2O_3 &= CaSO_3 + S \\ CaSO_3 + O &= CaSO_4 \end{aligned}$$

The combination of oxygen with the moist polysulfides is very rapid and quantities of the tetrasulfide or pentasulfide containing the same amount of calcium would absorb the same amount of oxygen and consequently produce the same amount of thiosulfate. This last named substance decomposes very slowly under ordinary conditions. For this reason, calcium sulfite is formed very gradually and the oxygen required to form the sulfate is absorbed slowly; too slowly, in the writer's opinion, to make it of insecticidal importance. Investigations made by the entomologist of this station indicate that calcium sulfite has practically no insecticidal effect upon San José scale.

The oxygen required to convert the polysulfides present in a given solution into thiosulfate can be easily estimated by the use of the methods of Harris.[3] The titration used in the determination of "mono-

[1] Bull. 154 and 234 Calif. Agr. Exp. Sta.

[2] Private correspondence.

[3] Tech. Bull. No. 6, Mich. Agr. Exp. Sta.

sulfide" (for explanation of this term see bulletin referred to) sulfur may be used in estimating the amount of oxygen which will combine with the polysulfide present to form thiosulfate. In this case, 1 cc. of tenth-normal iodine is equal to 0.0024 grams of oxygen. The writer suggests that this oxygen-consuming capacity might be expressed as the "oxygen number" (analogous to the iodine number of fats), this term meaning the amount of oxygen consumed expressed as per cent of the lime-sulfur solution, or, in other words, the number grams of oxygen absorbed by 100 grams of lime-sulfur.

Free sulfur is liberated from lime-sulfur by reactions represented by the following equations:

$$CaS_4 + 3\ O = CaS_2O_3 + 2\ S$$
$$CaS_5 + 3\ O = CaS_2O_3 + 3\ S$$
$$CaS_2O_3 = CaSO_3 + S$$

Since the oxidation of the polysulfide takes place rapidly there is a correspondingly rapid deposition of sulfur. The liberation of sulfur due to the decomposition of the thiosulfate is much less rapid. Considering everything, however, it appears that all of the sulfur liberated might be of equal insecticidal value; at least, there is no good evidence available to the contrary. The chemical estimation of the sulfur which will be deposited from a given amount of lime-sulfur solution can be made without difficulty. All of the sulfur present in the polysulfides in excess of that necessary to form the "monosulfide" of calcium combined in this form, would be deposited; also one half of the sulfur present as thiosulfate in the original solution. The chemical methods for making these determinations have already been worked out in a thorough manner[1] and it is unnecessary to go into a detailed discussion of them here. The author suggests that the total free sulfur which would be deposited might be expressed as the "available sulfur number," this term meaning sulfur deposited expressed as per cent of the original lime-sulfur solution.

The third insecticidal property mentioned above is not so easily estimated. In fact, it is not definitely known why the spray solution softens the wax on scale insects. It might be stated, however, that calcium thiosulfate is neutral in solution and gives no caustic effect on the hands, while solutions containing calcium polysulfide are very caustic. It is true that there is a small amount of calcium hydroxide in lime-sulfur solutions, due to hydrolysis of the polysulfide, but it is present in insufficient quantity to say that the caustic properties are

[1] Jour. Amer. Chem. Soc. 27, 244 (1905).
Jour. Ind. Eng. Chem. 2, 271 (1910).
Tech. Bull. No. 6, Mich. Agr. Exp. Sta.

due to the alkalinity of the solution. The writer's experience in handling the spray simply verifies the correctness of Shafer's statement that "the so-called caustic action of the wash on the hands seems rather due to its strong reducing power (power to absorb oxygen)[1] than to the alkalinity of the solution." It is very possible that this reducing power may also cause the softening of the so-called wax on the scale insects. If this be true, the "oxygen" number mentioned above would give its quantitative measurement. At any rate, the power of the spray to soften the so-called wax is evidently due to some property of the polysulfides and in the light of present knowledge no definite statement can be made regarding its exact nature nor its exact quantitative analytical measurement.

In conclusion, the writer wishes to state that the above discussion is merely a suggestion to chemists and entomologists. There may be other insecticidal properties of the spray than those mentioned and it is possible that the ordinary methods of valuation now in use are the best. If not, the discussion given here may prove to be of some value.

NOTES ON COCCIDÆ FOUND IN PERU

By E. W. Rust, *Assistant Government Entomologist, Lima*

Prior to the year 1909 very little entomological work had ever been done in Peru and, as a consequence, very little was known and almost nothing had been published relative to the insect life of this country. However, during the latter part of the year just mentioned, the Peruvian government established a bureau of entomology under the able guidance of Prof. C. H. T. Townsend. Among the many activities of the latter was the beginning of a collection of Coccidæ from as many hosts as possible and from all parts of the Republic, with complete notes relating to each lot of specimens.

When the writer arrived, during the latter part of 1911, this collection already numbered hundreds of lots of specimens, at that time all unidentified, many of which were of the same species but upon different hosts or from different localities. Since that time the collection has been greatly augmented both by Professor Townsend and by the writer whose pleasant task it has been to determine the species represented.

In many cases the coccids herein noted have never before been reported from South America and with the exception of only two or three species, this constitutes the first publication of their occurrence

[1] Words in parenthesis inserted by the author.

in Peru. It is with the idea of making known the new localities and new hosts of those coccids already determined, that this article is written.

Aspidiotus camelliæ Sign.

This coccid has been found more or less abundant in all parts of the Republic, so far visited, where its hosts exist but scarcely ever in sufficient numbers to cause it to be regarded as a serious pest. It is evidently kept well in check by microhymenopterous parasites which are not only numerically great but also include several different species.

Collected as follows in Peru: on *Salix humboldtiana*, Acobamba (elevation 9000+ feet); *Cordyline terminalis*, Lima; *Nerium oleander*, Lima; *Baccharis* sp., Huancayo. Also noted on many other plants throughout the Republic.

Aspidiotus cyanophylli Sign.

To date this scale has been collected only four times by the writer, but has, doubtless, been overlooked in other instances and will be collected in the future as this work progresses, as this climate seems very suitable to its multiplication.

On *Musa paradisiaca*, Hacienda San Jacinto (Department of Piura); *Carica papaya*, Lima, *Cinnamonum* sp., Lima; *Cocos* sp., Lima.

Aspidiotus cydoniæ Comst.

Collected as follows: on peach, Lima; rose, Hacienda Santa Clara (Department of Piura); *Morus alba*, Lima; *Eriobotrya japonica*, *Cinnamonum* sp., Lima; *Nerium oleander*, Samán (Department of Piura).

Aspidiotus hederæ Vall.

Collected as follows: on *Dracæna* sp., Lima; *Cordyline terminalis*, Lima; *Dianthus chinensis*, Lima; *Ligustrum japonicum*, Lima, and at Arequipa; *Magnolia grandiflora*, Lima; *Nerium oleander*, Lima; *Eriobotrya japonica*, Lima.

Aspidiotus juglans-regiæ Comst.

This scale is evidently an introduction, probably of the last few years, and has not yet become widespread in this country, although climatic conditions around Lima (near where the specimens were collected) seem favorable to its reproduction.

Recorded from Peru only in one instance as follows: Hacienda Ñaña (between Lima and Chosica) on *Juglans* sp.

Aulacaspis rosæ Bouché

This insect is a pest in many gardens throughout the country and is especially damaging to the roses, which it very often kills outright. Up to the present date it has not been noted on any other host and only a more extended search can determine whether it has extended its ravages to the native rosaceous flora. In this climate it has several broods per year and all stages can be found at almost any season. Adult

males are very numerous and their snowy puparia usually so cover the rose twigs as to make the latter appear as if white-washed.

This office has many notes on the collection of *A. rosæ*, among which are the following: on rose, Lima; on rose, Piura.

Ceroplastes sp. (near *ceriferus*)

Owing to the small number of specimens of this coccid and to a lack of literature describing the species of this genus, the writer cannot be *positive* of their specific determination, but the specimens in the government collection so closely agree with the description of *C. ceriferus* in "The Coccidæ of Ceylon" by E. E. Green, that they may be regarded as belonging to this species until proven something else. Moreover, *C. ceriferus* has been reported from Chili, Mexico, Antigua and Jamaica, in all of which exist climatic and other conditions very similar to those in the section of Peru where these specimens were found, so it is not surprising to find the aforesaid species present in this country as well.

Collected only at Huancabamba, on a thorny bush thought to be a species of *Mimosa*.

Chrysomphalus n. sp.? (near *rossi*)

Differs from available published descriptions of *C. rossi* in the presence of paraphyses, in having fewer circumgenital pores and in that the plates are broader, blunter and not so long and slender, and are less serrated.

On *Araucaria excelsa*, Lima; *Araucaria bidwilli*, Lima.

Coccus hesperidum Linn.

C. hesperidum is found attacking a large variety of hosts very generally throughout the Republic, but so thoroughly is it held in check by its numerous microhymenopterous parasites that it very seldom does appreciable damage and even in such isolated cases destruction by artificial means scarcely seems necessary.

Collected as follows: on a variety of *Dianthus chinensis*, Samán (Department of Piura); *Mangifera indica*, Coscomba (Department of Piura); *Cordyline terminalis*, Lima; *Datura arborescens*, Samán, (Department of Piura); *Ficus nitida*, Matucana; orange, Coscomba (Department of Piura).

Diaspis boisduvalii Sign.

It has often been noted by the writer that this coccid seems to have a decided preference for monocotyledonous plants and is especially troublesome on palms, often killing young plants. It is a very common scale in this country, being widely distributed and thriving out-of-doors in perfect vigor.

Recorded from this Republic on: *Cocos coronata*, Lima; *Areca nobilis*, Piura; *Areca nobilis* and *Pandanus utilis*, Lima.

Diaspis echinocacti Bouché

Found occasionally throughout the Republic on cactus, but, so far as known, attacking no other group of plants.

Recorded as follows: on *Opuntia* sp., Lima; on *Opuntia arborescens*, Acobamba.

Fiorinia fioriniæ Targ.

Of common occurrence upon various species of ornamental plants in the gardens and parks of various Peruvian towns but, so far, not collected on wild vegetation.

Noted as follows: on *Cocos* sp., Samán (Department of Piura); on *Phormium tenax*, Lima; on a cultivated, climbing *Asclepias*, Lima.

Hemichionaspis minor Mask.

This coccid is so closely related to *H. aspidistræ* as to be thought by some authorities to be inseparable from, or at least only a variety of, the latter. To the writer, however, it seems a valid species which can generally be separated from *H. aspidistræ* by various small differences; these taken separately, seem inconsequential, but in the aggregate cannot be denied recognition. The scale of *H. minor* is, as a rule, lighter in color than that of *H. aspidistræ,* is somewhat coarser in texture, thicker, not quite so slender and dainty looking and does not seem so smooth and shiny. The exuviæ of *H. minor* appear a trifle smaller in proportion to the size of the scale and contrast more in color with the latter, being of an amber to light-brown color or even of a dirty, dark-brown.

The median lobes of the adult insect seem to project a trifle more than in *H. aspidistræ* and lobes two and three do not seem quite so distinct as in the last mentioned species.

In Peru *H. minor* is known especially as a cotton plague and as such it is doing a great amount of damage in the northern cotton regions. The generally accepted opinion as to its introduction (as previously published by Prof. C. H. T. Townsend) is that it entered through the Port of Paita on some plants which were, doubtless, set out in the vicinity of Piura during the last eight or ten years, and from this focus it has gradually been spreading through the cotton fields of the Piura-Chira valleys until it has now become a very serious check upon not only the quantity but also the quality of cotton produced.

As cotton is by far the most important product of the region named, it is only natural that the "piojo blanco," as *H. minor* is there called, should be regarded primarily as a cotton pest, but its attacks are by no means confined to that plant and *Salix humboldtiana* as well as *Ricinus communis* are close seconds as hosts. This office possesses a great many notes relative to such attacks in many localities and at different dates and that the coccid in question is an omnivorous feeder

cannot be doubted after a glance at the following list of host plants, all but two of which are in addition to those recorded in Mrs. Fernald's "Coccidæ of the World." All localities mentioned are in the Department of Piura, Peru.

Collected quite generally on cotton; *Phaseolus* sp., *Ricinus communis, Salix humboldtiana*, watermelon, Coscomba; *Capsicum* sp., Sol Sol; *Ricinus communis*, Catacaos, and Macacará; *Prosopis juliflora*, Coscomba; *Asparagus officinalis*, Piura; *Sesbania* sp. Coscomba; *Yucca gloriosa*, Samán; Coscomba; Piura, "cereza," Coscomba; watermelon, Catacaos; *Malvastrum* sp., Hacienda San Jacinto.

Lepidosaphes beckii Newm.

Many years ago good oranges were grown in the vicinity of Lima but at present even a citrus *tree* is a rarity and all the citrus fruit is brought either from Ecuador, or small, well isolated valleys in different parts of the Peruvian Republic. This situation is caused by the ravages of various insect pests, among the most formidable of which is *L. beckii*, but today the scale is rarely encountered for the simple reason that its food plants have nearly all been destroyed wherever the scale has gained a foothold. Although many parasites are present they do not dominate their hosts to such an extent as to make the raising of citrus fruit, on a commercial scale, an attractive proposition in this section.

Lepidosaphes beckii has been collected by this office as follows: on orange trees, Lima, and at Hacienda Ñaña (between Lima and Chosica).

Two other species of *Lepidosaphes* have been collected in this Republic but as yet neither of them has been classified. The writer has repeatedly taken a small, light-colored species from citrus trees in the Department of Piura where it is a great hindrance to the growth of all species of *Citrus*, being especially common on the orange. It is also common on a plant which is parasitic on *Prosopis juliflora*.

The other species is very like *L. beckii*, but a close examination discloses differences, the best marked of which is its larger size and slightly different color. Taken by Professor Townsend on oranges from Pacasmayo.

Orthezia insignis Dougl.

Collected as follows: on *Justicia* sp., Lima; on *Ligustrum japonicum*, Lima; on *Duranta plumieri*, Lima; on *Jacaranda punctata*, Lima; on *Bignonia stans*, Lima.

Pseudaonidia articulatus Morg.

This coccid is the commonest, and most widely distributed of all those found in this country and is also the most omnivorous feeder, attacking as it does a very wide range of food plants. The hosts most generally infested are the different species of *Ficus* and *Citrus* trees, the latter being infested, almost without exception, throughout the Repub-

lic. In appearance *P. articulatus* is very like the red scale of California (*Chrysomphalus aurantii*) but here it does even more damage, in proportion to the number of citrus trees grown, than does the red scale in the citrus growing districts of the United States. But in considering this statement one must bear in mind that fumigation is never practiced in Peru and that parasites, even though exceptionally numerous, do not seem even to be a serious check on the multiplication of this insect, not to mention controlling it.

The following is a list of hosts and the localities where collected, to date, but additions are constantly being made as this inquiry into the coccid fauna of Peru progresses. Collected on: orange, Hacienda Mallares (Department of Piura); orange, Pueblo Tamarindo (near Paita); orange Chapairá (near Piura); orange, Hacienda Mallares (Department of Piura); orange, Coscomba (near Piura); lemon, Hacienda San Jacinto (near Paita); lime, Hacienda San Jacinto (near Paita); orange, San Bartolomé (Department of Lima); orange, Muñuela (Department of Piura); orange, Coscomba (near Piura); rose, Piura; *Anona muricata* and orange, Perené Colony (in the interior of Peru); *Anona cherimolia*, Chosica; *Ficus nitida*, Lima; *Ficus nitida*, Hacienda Ñaña (between Lima and Chosica); *Sambucus peruviana*, Piura, and Hacienda San Jacinto (near Paita); *Anacardium occidentalis*, Ñomala (in the Andean foothills, Department of Piura; *Jasminum arabica*, Lima; *Jasminum azoricum*, *Nerium oleander*, Lima; *Ligustrum japonicum*, Lima; *Plumieria* sp., Piura; *Cocos coronata*, *Washingtonia filifera*, *Erythria edulis*, *Kentia* sp., and *Cycas revoluta*, Lima; *Bignonia stans*, Piura; *Magnolia grandiflora*, Lima; *Eriobotrya japonica*, Chosica.

Pseudococcus citri Risso.

The above insect, in temperate climates, is generally considered as a greenhouse pest but in the warm, equable climate of Peru it is to be found out-of-doors in all localities where its food plants grow. It is very subject to both parasitic and predaceous enemies, however, and has not as yet been noted in any abundance in any one locality, although a slight search will reveal it almost anywhere in limited numbers. It is not a serious menace to any cultivated crop and, owing to this fact and its general distribution and comparatively slight numbers, only a few notes relating to it have been accumulated.

Collected on: *Coffea arabica*, Lima; *Gossypium peruvianum*, Hacienda San Jacinto (near Paita), and throughout the Department of Piura at different dates; *Asparagus officinalis*, Sol Sol (Department of Piura), (Rust) and Hacienda Mallares (near Paita); cotton, Lima.

Pulvinaria sp. nov. (?)

In the Department of Piura a species of Pulvinaria has repeatedly been collected but always in the immature stages so that it could not be classified. It is of medium size and green in color, and the beginning of an ova-sac, in a few cases, distinguished it from all coccus-like forms. Never seen in damaging numbers.

Collected on: *Gossypium peruvianum*, Hacienda Samán (near Paita), and at Paccha

(Department of Piura); *Batata edulis*, Sullana (Department of Piura); *Bidens* sp., Sullana.

Saissetia hemisphærica Targ.

This well-known coccid is of quite general occurrence in Peru, but as a rule the individuals are rather scattering, there often being only one or two on a single leaf or stem. Rarely, indeed, is it found in masses and even in such cases the individuals are soon killed off by parasites, so that a heavy infestation, with its consequent damage to the host, is very unusual.

Recorded as follows: on *Asparagus officinalis*, Piura; *Plumieria* sp., Piura; *Baccharis* sp., Perené Colony (interior of Peru); *Tessaria* sp., Perené Colony; *Bignonia stans*, Piura and Lima.

Saissetia oleæ Bern.

While the female of this species is common in many parts of Peru, the males have been seen here upon only a single occasion. On July 15, 1913, the writer collected hundreds of male propupæ on the undersides of the leaves of *Asclepias curassavica* at Chosica, from which many perfect males emerged within the next few days. Hitherto, California is the only locality from which the males have been reported (see Bulletin no. 223, Calif. Agricultural Experiment Station by H. J. Quayle and E. W. Rust), and it is of much interest to the writer again to be able to record them, especially at such a distance from where they were originally found.

S. oleæ has been noted as follows by this office; on cotton (*G. peruvianum*), Somate (Department of Piura), and at Catacaos; on cotton, Vitor (near Arequipa), and Coscomba (near Piura); on *Nerium oleander*, Lima; on *Asclepias curassavica*, Lima, and Chosica.

THE ECONOMIC STATUS OF THE FUNGOUS DISEASES OF INSECTS

By R. W. Glaser, *Bureau of Entomology*

There can be no doubt that at certain times of the year, under certain conditions, epidemics of fungous diseases naturally contribute much toward controlling noxious insects. This, however, is a balance established by nature of her own accord. Can we help her?

Let us suppose that a given locality is heavily infested by a noxious insect; also that a number of individuals in this locality have died from fungus parasitism and, lastly, that we have found an infested locality free from such a fungus. We will naturally ask ourselves the following questions:

(1) Can we cultivate this fungus?

(2) Can we introduce it into the infested locality where it is not known to occur?

(3) Will the fungus establish itself and will it spread and become effective?

On the whole, a favorable answer can be given to the first two questions. Many of the parasitic fungi have been cultivated on artificial media or on living insects kept in confinement. Such fungi have been introduced among healthy insects when the occasion warranted such procedure. The third question, however, has offered difficulties which in most cases have been insurmountable. Fungi are very dependent upon external conditions and in many cases the apparent absence of a particular fungus in a locality is usually an index of conditions unfavorable for its development, and an artificial introduction will be useless. If a fungus does establish itself in a locality it may not spread far from the centers of artificial infection, showing that conditions are favorable in and near the centers of infection, but not beyond them. A certain amount of success has been achieved in one case and I will give an account of this after having presented some of the difficulties which were encountered by competent investigators who showed that in general the economic value of certain fungi has been overestimated.

In 1892, Franz Tangl, at one time interested in this subject, and now a well known physiologist at the University of Budapest, performed some infection experiments on nun moth caterpillars by using spore emulsions of *Botrytis bassiana.* In the laboratory the experiments succeeded, since all of the infected caterpillars died of "muscardine." Infection experiments in nature, however, where infested trees were thoroughly sprayed with spore emulsions, gave negative results. The nun moth caterpillars flourished as before. V. Tubeuf, who has done a great deal of work on caterpillar diseases, tried a series of similar experiments, and likewise obtained negative results when he tried to infect caterpillars in nature with *Cordyceps militaris.*

Recently Billings and Glenn (1911) in attempting the artificial use of *Sporotrichum globuliferum,* the etiological factor of the white fungus disease of chinch bugs in Kansas, have reached very similar conclusions. In a summary of their experiments, they say:

(1) "In fields where the natural presence of the fungus is plainly evident, its effect on the bugs cannot be accelerated to any appreciable degree by the artificial introduction of spores.

(2) "In fields where the fungus is not in evidence spores introduced artificially have no measurable effect.

(3) "Apparent absence of the fungus among chinch bugs in a field is evidence of unfavorable conditions rather than lack of fungous spores.

(4) "Laboratory experiments can be made to prove that artificial infection accomplishes results upon bugs confined in cramped quarters and without food, but in the field, where fresh and usually drier air prevails and food is abundant, an entirely different situation is presented."

In 1912, Morrill and Back performed a large series of experiments in Florida to determine whether or not fungi could be used artificially in suppressing the white fly in the citrus groves. It has been known that fungous diseases are very important factors in the natural control of this insect. The most important species of fungi in this respect are *Ægerita webberi* Fawcett, the brown fungus, *Aschersonia aleyrodis* Webber, the red fungus, and *Aschersonia flavocitrina*, the yellow fungus.

In attempting to use the above fungi artificially Morrill and Back concluded that:

(1) "The fungus parasites thrive only under suitable weather conditions during a period of about three months each year; generally speaking the summer months in the case of the two Aschersonias and the fall months in the case of the brown fungus.

(2) "Under natural conditions, without artificial assistance in spreading, the fungi have ordinarily, in favored localities, controlled the white fly to the extent of about one-third of a complete remedy through a series of years.

(3) "The infections secured by artificial means of introducing fungi, while successful in introducing the fungi, have thus far proved of little or no avail in increasing their efficacy after they have once become generally established in a grove.

(4) "Experiments by the authors, and by citrus growers in coöperation with the authors, involving the treatment of thousands of trees with suitable "checks" or "controls" have shown that when fungus (red or yellow *Aschersonia*) even in small quantities is present in a grove, there is no certainty that from three to six applications of fungus spores in water solution will result in an increased abundance of the infection on the treated blocks of trees by the end of the season. In some of the most important and carefully planned and executed experiments, the fungus has increased more rapidly in sections of the groves which were not sprayed with spore solutions than in the experimental blocks."

We must now consider *Entomophthora aulicæ*, the brown-tail fungus, which is the only case familiar to me where an artificial use of a fungus has proved successful to a certain extent. Speare and Colley, the authors of a paper on this subject in 1912, say that it can not be re-

garded as a "cure all" for the brown-tail moth, but is very important as a powerful check.

They give the following directions for the use of the fungus: "The Entomophthora under consideration may be used effectively in the spring and early summer, when the larvæ have left their nests and in the autumn for several weeks before the webs of the new broods are closed for the winter. During both of these periods the rapid spread of the disease is largely dependent on weather conditions, and when these conditions—warm nights and damp atmosphere—favor the growth of the fungus, artificial distribution yields truly satisfactory results, and may bring about enormous and widespread destruction." . . . "In the spring, when the caterpillars are scattered all over the trees, it is comparatively easy to place the infected larvæ in among them, but in the autumn, when they are localized, feeding in the immediate vicinity of the nest, it is necessary to infect individual nests. Experience seems to point to the autumn, however, as the more advantageous time to start the artificial epidemic."

A detailed account of the methods used for the propagation and dispersion of the brown-tail fungus will be found in the paper of these authors. Suffice it to say that the fungus has accomplished much good and when the proper conditions for its introduction are selected, a destruction of from 63 to 100 per cent. of the caterpillars in the planted areas can be depended upon. An intelligent use of the brown-tail fungus should be encouraged, for the results obtained in Massachusetts during the last two or three years justify a serious consideration of the matter. Professor Roland Thaxter, the well-known cryptogamic botanist, told me that he could not think of any way in which the State Forester of Massachusetts could spend a few thousand dollars a year to better advantage than in the propagation and dispersion of the brown-tail fungus.

ON THE CAPTURE OF LIVING INSECTS BY THE CORN-FIELD ANT (LASIUS NIGER AMERICANUS)

By Wesley P. Flint

During some experimental work on the corn-root aphis done at Bloomington, Ill., in the summer of 1909, the movements of *Lasius americanus* were closely observed every night for nearly two months by Mr. G. E. Sanders and myself. It was frequently noticed that on warm nights, when these ants were very active, they would attack and kill many small insects that came near their nests. This was first seen on a very warm night in August, when a large nest of ants

of this species was being watched by the aid of a red carbide lamp. A back-swimmer (Notonectid) happening to alight among several *Lasius* workers, one of the ants at once seized the back-swimmer by one of its legs. In a few seconds twenty or more ants were crowded about the insect, many holding to it, and in less than two minutes it had been dragged into the *Lasius* nest. During the next few minutes the ants killed a number of small Jassids that, attracted by the lamp, alighted among them. Often an ant would capture a Jassid as large as itself and carry it into the nest.

On this and other warm nights when the ants were very active, a number of living insects were placed near their nests, and in nearly all cases these were quickly caught and killed. If at first only a few ants were on the ground near the nest entrance and a small insect such as *Diabrotica longicornis* was dropped among them, as soon as the ants on the surface began to struggle with the beetle, others would come out of the nest in such numbers that several hundred would sometimes be gathered about the entrance. When a large number were assembled in this way, they would attack and kill insects of considerable size. *Diabrotica 12-punctata*, *D. longicornis*, and *Agonoderus pallipes* were readily killed. The ants seem to be especially fond of the last-named beetle for food, as they may often be seen dragging it to their nests. *Heliothis obsoleta* larvæ, nearly full grown, were killed after a short struggle; and even adult Epicautas, both *E. marginata* and *E. vittata*, were killed after a hard struggle, as were also many small beetles and moths. *Lasius* does not, however, seem able to kill Pentatomids of any size. Insects of this family were frequently dropped among the ants, but always escaped if not first injured. Even when killed they were seldom dragged within the nest, and it would seem that the odor of these insects is offensive to the ants.

One point of considerable interest was the manner in which the ants caught the insects. In very many cases they would seize their prey by the legs and hold them in this way until killed by the bites of other ants on the head or abdomen; but more frequently an ant would get on the back of its victim and hold it by the antennæ until killed by other workers. In some cases an insect would take flight and carry the ants, hanging to its legs, for some distance. The effect of the ant bites must have been very poisonous to most of the insects killed, as *Diabrotica longicornis* was often killed in thirty seconds, *Agonoderus pallipes* in a minute or less, and other larger insects in a surprisingly short time. It was very evident that when very active *Lasius americanus* will attack any insect that happens near its nest; and, while many escape, the total number killed by these ants in the course of a season must be very large.

Lasius was often found in large numbers in the piles of cow and horse manure dropped by cattle and horses in pastures. It was noticed that, when this manure was disturbed, the ants promptly carried away any dipterous larvæ that might be exposed. Examination of a large number of these piles of droppings showed that the number of dipterous larvæ found in the droppings where *Lasius americanus* was present was much less than in those in which no ants were found. Several nearly fresh piles of droppings, containing large numbers of maggots but no ants, were taken from the pastures and placed in a corn field over a large nest of *Lasius americanus*. When examined three days later only one puparium and one larva with ants feeding upon it was found. There had been at least seventy-five maggots in the manure when it was placed over the ants' nest.

Office of the Illinois State Entomologist.

THE CALIFORNIA PEAR THRIPS IN MARYLAND

By W. M. Scott,

Research Department, Thomsen Chemical Co., Baltimore, Md.

On April 25, 1913, the writer observed a blighted condition of the blossoms and leaves in a small Kieffer pear orchard near Baltimore, Md., and a closer examination disclosed the fact that the trees were literally alive with thrips. The leaves were curled and blackened at the tips and around the margins, and most of the blossom clusters had been destroyed.

The common pear thrips of California, *Euthrips pyri* Daniel, was suspected, but only larvæ were present, the adults having disappeared, and the species could not therefore be identified.

Keeping this interesting outbreak in mind, the writer visited the same orchard again on April 22, 1914, when the blossoms were beginning to open, and found adult thrips present in great numbers. Specimens were sent to Prof. A. L. Quaintance, of the Bureau of Entomology at Washington, who reported that Mr. J. D. Hood, of the Biological Survey, had examined them and identified the species as *Tæniothrips* (*Euthrips*) *pyri* Daniel.

This establishes a new locality for the pear thrips which has the reputation of being the most destructive fruit tree insect in California. Foster and Jones[1] place "the damage caused by the pear thrips, in the Santa Clara Valley alone, during the years from 1904 to 1910 at nearly $2,000,000." The question of interest to both entomologists and

[1]U. S. Dept. of Agr., Bur. Ent. Cir. No. 13, p. 2.

fruit growers is, will it prove to be as destructive in the East as it has been on the Pacific Coast? The results of its work in the Maryland orchard indicate that it is capable of completely destroying a crop of Kieffer pears. On May 5, 1914, the writer examined this orchard again and found that, although the trees had bloomed profusely, no fruit had set, the blossom clusters having dried up. There was no crop in 1913, but this might have been due to a spring frost which the owner at the time thought killed the blossoms. In 1914, however, there was no frost during the blooming period and no pear blight could be found in the orchard, so that the thrips was apparently the sole cause of the loss this year.

For many years this insect, so far as known, was confined to a few counties of California, but in 1912 Parrott[1] reported it as occurring at several points in the Hudson River Valley of New York and the Maryland occurrence establishes it in a third state. Its discovery in other localities will probably follow in rather rapid succession until it becomes one of our common orchard pests.

So far as the writer knows, the Maryland outbreak is at present confined to the orchard of Mr. Roland Phelps at Brooklyn, about four miles from Baltimore. This orchard consists of about two hundred Kieffer pears with perhaps half a dozen Le Conte and Seckel pears mixed in. These latter varieties were affected almost, if not quite, as much as the Kieffer. The thrips also occurred on some nearby peach and apple trees, but caused very little damage to these. Other pear orchards in the same neighborhood were examined, but no thrips found.

DESCRIPTION OF A NEW SAWFLY INJURIOUS TO STRAWBERRIES [2]

By S. A. Rohwer

The following species is described at the request of Professor R. L. Webster who has been working on the life-history of this species for a number of years and who has prepared a paper dealing with the biology and economics of the species of *Empria* injurious to strawberries in Iowa.

The species of *Empria* are closely related and the group is in bad need of revision. As far as the author's experience with the genus

[1] N. Y. Agr. Expt. Sta. Bul. No. 343, p. 13.

[2] Contribution from the Branch of Forest Insects, Bureau of Entomology, U. S. Department of Agriculture, Washington, D. C.

has gone he is of the opinion that the most reliable specific characters are to be found in the sheath, saw, antennæ, certain parts of the head and color. Certain characters of the head such as the exact extent and definition of the median fovea and antennal furrows and the exact dentations of the clypeus are, it would seem, subject to variation and cannot be used as rigidly as in other groups.

Empria fragariæ, new species

Judging from the literature this species is related to *castigata* MacGillivray. Specimens were sent to Dr. A. D. MacGillivray who compared them with his type and stated that they differ from that species in the "form of the saw guide which has the distal end truncate with rounded corners, while in the specimen sent the lower corner is rounded off. The median fovea is only a rounded scar in *castigata* and a deep rounded pit in the specimen sent." This species has no doubt been identified as *ignota* Norton, and probably some of the writings dealing with the biology and economics of *ignota* refer more properly to *fragariæ*.

Female: Length 6.5 mm.; length of antennæ 2 mm. Clypeus more coarsely sculptured toward the apex, the apical margin tridentate, the lateral lobes broadly, obtusely triangular with the median tooth small and obtuse; supraclypeal area convex, slightly more strongly convex ventrally, but in outline nearly rectangular; antennal and supraclypeal foveæ confluent, but the former are not as deep as the punctiform supraclypeal foveæ; antennal furrows complete but not as deep opposite crest; middle fovea elongate, and more or less connected with the elongate depression from the anterior ocellus; postocellar area well defined; postocellar furrow nearly straight; a deep furrow from the anterior ocellus to the postocellar furrow; postocellar line distinctly shorter than the ocellocular line; face and front to the level of the anterior ocellus distinctly sculptured; vertex and posterior orbits shining, with setigerous punctures; antennæ short, stout, the third antennal joint distinctly longer than the fourth, the fourth and fifth subequal; mesonotum shining, impunctate; stigma broader at base where it is subangulate, gradually tapering to the radius from which it is obliquely truncate to the costa; third cubital cell slightly longer than the second, twice as wide anteriorly as basally; hind wings with one discal cell; sheath straight above, obtusely rounded at the apex and gently rounded on the lower margin. Black; two elongate spots on the posterior margin of the pronotum, tegulæ almost entirely, lateral spots on the second, third and fifth tergites, white; legs black; apices of the four anterior femora, four anterior tibiæ beneath, extreme base of the posterior tibiæ, white; wings dusky hyaline, venation dark brown.

Male: Length 5 mm. Agrees fairly well with the above description of the female. The hypopygidium is broadly rounded.

According to the specimens examined this species varies in the dentation of the clypeus, inasmuch as the median tooth is decidedly reduced in some specimens and slightly accentuated in others (in these latter the supraclypeal area and clypeus become subcarinate); and in the extent of the middle fovea, as the impressed line from the anterior ocellus varies in depth and definition. The most reliable criterion for determining this species is the shape of the sheath, general color, well-defined postocellar area and short antennæ.

Ames, Iowa. Described from one female (type) labelled "Experiment 113 (1911), April 7, 1912," and one male (allotype) labelled in the same fashion. The paratypes bear various "Experiment" numbers and most of them are reared. Certain specimens of this species were also collected around Storm Lake, Iowa, on May 2, 1912 by R. L. Webster.

Type, allotypes and paratypes in the U. S. National Museum under Catalog Number 18357. Other paratypes in the collection of Dr. A. D. MacGillivray and in the collection of the Experiment Station at Ames, Iowa.

ARTHROCNODAX CONSTRICTA n. sp.

By E. P. Felt, *Albany, N. Y.*

The midges described below were reared from garden beans infested with the common red spider, *Tetranychus bimaculatus*, and probably predaceous thereupon. The specimens were collected by Thomas H. Jones, June 21, 1913, at Rio Piedras, P. R. The species runs in our key to *A. rhoina* Felt, from which it may be easily separated by the greater length of the distal part of the stem of the fifth antennal segment and the marked differences in genitalia.

Male: Length 1 mm. Antennæ fully as long as the body, sparsely haired, yellowish-brown, yellowish basally; 14 segments, the fifth having the basal portion of the stem with a length one-fourth greater than its diameter, the distal part with a length two and one-half times its diameter. Palpi; the first segment subquadrate, the second narrowly oval, the third and fourth nearly equal, each with a length nearly four times the diameter. Mesonotum yellowish brown, the submedian lines yellowish. Scutellum yellowish brown, lighter apically, postscutellum yellowish. Abdomen yellowish brown. Halteres pale yellowish. Coxæ and legs mostly yellowish straw, the pulvilli nearly as long as the claws. Genitalia; basal clasp segment long, slender; terminal clasp segment rather long; dorsal plate short, broadly and roundly emarginate; ventral plate long, broad, roundly truncate; style long, rather slender and strongly constricted near the distal third.

Female: Length 1.25 mm. Antennæ nearly as long as the body, sparsely haired, yellowish, the fifth segment with a stem one-fourth the length of the cylindric basal enlargement, which latter has a length about two and one-half times its diameter, the fourth palpal segment distinctly longer than the third. Ovipositor pale yellowish, the terminal lobes narrowly oval, tapering distally and thickly haired. Other characters nearly as in the male. Type C. a2572.

JOURNAL OF ECONOMIC ENTOMOLOGY

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The editors will thankfully receive news items and other matter likely to be of interest to subscribers. Papers will be published, so far as possible, in the order of reception. All extended contributions, at least, should be in the hands of the editor the first of the month preceding publication. Contributors are requested to supply electrotypes for the larger illustrations so far as possible. The receipt of all papers will be acknowledged.—EDS.

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The Philadelphia meeting promises much to prospective attendants. Its convenient location in respect to the more active entomological centers indicates a record-breaking gathering with a corresponding enthusiasm. Discussion and criticism based upon numerous viewpoints means the elimination of the unsound and the confirmation of results based upon correct fundamentals. The historical associations and the opportunities to consult the older collections of American insects, some very rich in types, present attractions not duplicated by many localities.

The continuance and spread of the fierce struggle in Europe means that little along scientific lines may be expected from the devastated areas for some time, possibly for years, and lays upon Americans an increasing responsibility for work along productive lines. The opportunities for investigation of the relation of insects to disease are particularly good and, as pointed out in a recent presidential address, relatively few have given attention to this phase of our science. This is especially true in America. Corps of practical entomologists devote their entire time to a study of insects injuring certain crops and, as yet, almost nothing of the kind has been attempted in this country. The exhaustive studies of purely agricultural insects have yielded practical results of great value and the same may be expected to follow a similar concentration along other lines.

Reviews

Die wichtigsten Krankheiten und Schädlinge der Tropischen Kulturpflanzen, by Dr. Friedrich Zacher, Band 1. 152 pages, 58 text figures. Hamburg. Verlag Fr. W. Thaden. 1914. (Deutsche Tropen-Bibliothek Bd. 10.)

This little volume treats of the insect and other animal pests as well as the bacterial and fungous diseases which attack tropical plants. The author explains the manner in which diseases are spread by animals, and how they often follow the attacks of insects.

The greater portion of the book, pages 39 to 152, is devoted to a discussion of the pests of cotton, cocoa, coffee and tea. Each important pest is treated separately and remedial treatment is recommended. Most of the illustrations are made in half-tone from drawings or photographs and are of fair quality. The book is supplied with a table of contents, but there is no index.

W. E. B.

Insects Injurious to the Household and Annoying to Man, by Glenn W. Herrick, pages i–xviii, 1–470, figs. 152. Macmillan Company. 1914.

We have in this small volume a concise and authoritative discussion of a large number of insects more or less directly injurious to man or his household possessions. The work is an indirect outcome of the studies of recent years upon insects as disease carriers, though the author does not attempt to exhaust this phase of the problem.

The first 34 pages are devoted to the house-fly while associated and much less important flies occupy the second chapter of 19 pages. The various mosquitoes, their habits and control are allotted about 50 pages. Short chapters are devoted to the bed-bug, cockroaches and fleas respectively. There is an excellent discussion of the various household ants, which, taken with the matter relating to the Termites (unlike though popularly associated forms) leaves little to be desired. The fabric, cereal and other food pests receive due attention and in concluding chapters there are discussions of human parasites, annoying pests, dry wood borers, poisonous or terrifying insects, presenting much of interest concerning common though not well-known forms. There is an excellent series of illustrations, mostly original, the printing is good and the arrangement tasty.

The general public will find in this volume much practical information presented in a pleasing, untechnical manner, while for the entomologist it means another exceedingly useful compilation illuminated by personal experiences in both North and South and supplemented by excellent bibliographies.

E. P. F.

Current Notes

Conducted by the Associate Editor

Mr. W. S. Regan has been appointed assistant in entomology at the Massachusetts Agricultural College.

Dr. J. R. Dickson, health officer of Trinidad, W. I., visited the Bureau of Entomology on September 18.

Mr. C. E. Wilson has succeeded Mr. R. E. Lobdell as assistant zoölogist and entomologist at the Mississippi station.

Dr. M. T. Smulyan has recently been appointed assistant to the state entomologist of Virginia, with headquarters at Blacksburg.

Mr. C. C. Hill, 1914, Massachusetts Agricultural College, is now connected with the Bureau of Entomology, and is located at Nashville, Tenn.

Mr. C. M. Packard, Bureau of Entomology, Hagerstown, Md., has been transferred to Hessian fly investigations at Wellington, Kan. Mr. Packard was married July 29.

Mr. W. V. King, Bureau of Entomology, has returned to New Orleans, La., where he will resume his work in the medical department of Tulane University.

Mr. H. C. Eagerton of the South Carolina Experiment Station has been appointed assistant entomologist in the Estacion Agronomica at Santiago de las Vegas, Cuba.

Mr. Ralph R. Parker, who has been studying the fly problem in Montana during the summer, has returned to continue his graduate work at the Massachusetts Agricultural College.

Mr. W. D. Pierce, Bureau of Entomology, has spent the month of September in determining the spread of the cotton boll weevil in Florida, Alabama and Mississippi.

Mr. H. P. Wood, Bureau of Entomology, has been granted leave of absence without pay for the purpose of taking a course in tropical medicine at Harvard University.

Mr. Stanley B. Freeborn, class of 1914, Massachusetts Agricultural College, is assistant and engaged in teaching economic entomology and veterinary parasitology, at the University of California.

Mr. James M. Langston, Bureau of Entomology, has been transferred from Nashville, Tenn., to Greenwood, Miss., where he will assist Mr. C. F. Turner in charge of the laboratory at that point.

Mr. A. W. Joblime Pomeroy has received the appointment as entomologist for the Department of Agriculture for southern Nigeria. He will proceed to his post from Liverpool on November 25.

Mr. J. D. Luckett, Bureau of Entomology, assigned to work under the Insecticide and Fungicide Board, at Vienna, Va., resigned September 5, in order to resume school work at Purdue University.

Mr. J. F. Strauss, Bureau of Entomology, has recently returned from a trip to Germany. While in Germany he collected a number of aphids on fruit and garden crops, which are of considerable interest.

At the invitation of the Florida Agricultural Experiment Station, Mr. W. W. Yothers, Bureau of Entomology, gave an address before the Citrus Seminar, held at the University of Florida, Gainesville, Fla., on September 22.

Mr. E. W. Laake, Bureau of Entomology, in company with Doctor Johnson, of the Bureau of Animal Industry, is investigating a serious outbreak of anthrax in western Texas, in which transmission by horse flies seems to be indicated.

Dr. William Saunders, author of "Insects Injurious to Fruits," since 1886 director of the Central Experimental Farms of the Dominion of Canada at Ottawa, and a member of this Association, died September 13, in his seventy-ninth year.

Mr. J. R. Horton, Bureau of Entomology, who is in charge of the Subtropical Field Station at New Orleans, La., was recently called to St. Louis, Mo., owing to the death of his brother as the result of an accident.

Mr. R. S. Vaile, collaborator, Bureau of Entomology, and until recently horticultural commissioner of Ventura County, Cal., will continue as collaborator with headquarters at Berkeley, where he has been appointed assistant professor of orchard management in the University of California.

Mr. W. E. Pennington, Bureau of Entomology, has been transferred from Wellington, Kan., to the Hagerstown (Md.) Laboratory to take the place vacated by C. M. Packard, who is now at Wellington, Kan., assisting Mr. E. G. Kelley in the Hessian fly investigations.

Mr. A. C. Cameron, a research student of the British Board of Agriculture, who has done notable work on the entomology of the soil of England, and who has spent several months in New Jersey, visited Washington on September 23.

Mr. M. M. High, entomological assistant, Bureau of Entomology, engaged in investigations of onion insects and the insect enemies of other vegetable crops at Knox, Ind., leaves these headquarters for Brownsville, Tex., where he will work on the same problems.

Mr. P. R. Myers, who for several years was connected with the division of insects in the United States National Museum, has received an appointment in the Bureau of Entomology, and has been detailed to assist Mr. W. R. McConnell at the Hagerstown (Md.) station.

Mr. William B. Parker, Bureau of Entomology, who has been engaged during the year in investigation of insects injurious to stored products and other projects at Sacramento, Cal., has accepted the position of farm adviser under the auspices of the University of California, with headquarters at Ventura, Cal.

Messrs. T. E. Holloway and G. N. Wolcott, Bureau of Entomology, returned from Europe about the middle of September. Mr. Holloway spent the entire month of August in Paris. He has returned to his station at New Orleans and Mr. Wolcott has resumed his work on *Lachnosterna* parasites at Urbana, Ill.

Mr. John N. Summers, Bureau of Entomology, who has been traveling in Europe for several months studying gypsy moth and brown-tail moth conditions, reached New York on September 12. Mr. Summers' return to Melrose Highlands, Mass., was somewhat delayed on account of the chaotic condition existing in Europe caused by the war.

Prof. A. L. Quaintance, Bureau of Entomology, left Washington about the middle of September for a trip through the Western States to confer with the men who are in charge of various deciduous fruit insect field stations. En route he will visit the following stations: North East, Pa.; Benton Harbor, Mich.; Grand Junction, Col.; Walnut Creek, Cal., and Wenatchee, Wash.

Mr. R. J. Fiske was appointed August 20 to the position of scientific assistant in the Bureau of Entomology, and has been stationed temporarily at Grand Junction, Col., where he will carry on investigations of the codling moth. Mr. Fiske is a graduate of the Massachusetts Agricultural College, class of 1910, and before entering the Bureau was engaged in entomological work in Porto Rico.

Mr. N. E. Shaw, chief inspector, Department of Agriculture, Columbus, Ohio, reports that several gypsy moth egg-clusters have been found on a shipment of stone received in Ohio from Massachusetts. This occurrence emphasizes the necessity of action being taken to prevent the distribution of egg-clusters into uninfested territory on shipments not subject to inspection by the Federal Horticultural Board.

Mr. Leonard S. McLaine, assistant to Dr. C. Gordon Hewitt, dominion entomologist of Canada, has recently returned to Canada. Mr. McLaine has been stationed at the Gypsy Moth Laboratory, Melrose Highlands, Mass., and has been engaged in collecting parasites of the gypsy moth and the brown-tail moth for shipment to New Brunswick and Nova Scotia, where an attempt will be made to colonize these species.

Mr. R. S. Woglum, Bureau of Entomology, who is in charge of the investigation of citrus insects in California, reports that the mealy bug investigations are progressing in a satisfactory manner. The life history of *Pseudococcus citri* for this season of the year has been determined, and preliminary life history work has been undertaken with a Chrysopid and Hemerobiid, predatory enemies of the citrus mealy bug.

There is an unusual outbreak of *Alabama argillacea* in the Southern States this season, and moths have appeared at lights in northern localities. Notes are desired from as many northern localities as possible regarding the exact dates of the first appearances of these moths, the dates of the maximum appearances and of the disappearance of the insect. Records of this kind have been kept for several years, and notes made during the present season will be especially valuable.

In connection with the work on the wilt disease of the gypsy moth, which is being carried on by Messrs. R. W. Glaser and J. W. Chapman, at the Bussey Institution, a number of quite similar polyhedral diseases have been found in native caterpillars. In case caterpillars are found which have apparently died from any bacterial disease in any part of the country, or at any of the field stations of the Bureau, a small number of specimens are very much desired for study. These can be shipped in a dry condition, but it will facilitate the work very much if a note accompanies the sending stating where the caterpillars were found and giving any other information about the species concerned.

The thirty-fourth annual Museum Expedition of the Department of Entomology, under the direction of the Curator of the Museum, Professor S. J. Hunter, spent the month of August in the Rocky Mountains, in Southwestern Colorado, working along the New Mexico line. There were six (S. J. Hunter, H. B. Hungerford, Raymond Beamer, Wm. Brown, fellow, F. Poose, research, the cook) in the party and they returned with eight thousand specimens.

A new edition of the Naturalists' Directory has just been published by S. E. Cassino, Salem, Mass. This directory is invaluable to naturalists since it is the means of bringing together students and collectors in all parts of the world through correspondence. The directory contains an alphabetical list of English-speaking professional and amateur naturalists in all parts of the world, also a list of scientific societies and periodicals. The price of the Directory is $2.50 in cloth binding and $2.00 in paper binding. Sent postpaid. As only a limited edition has been printed, it is advisable for any one wishing a copy to order at once.

Carnegie Scholars in Entomology Visit the United States

Mr. C. W. Mason has returned to England and will accept a post in one of the African colonies.

Mr. M. E. MacGregor has returned to England and will take a lectureship at Oxford in medical zoölogy.

Mr. H. A. Ritchie is still in this country and is now making a trip through the Southern States.

Mr. G. H. Corbett and Mr. E. Hargreaves reached Washington late in August and are at present visiting the stations at Clarksville, Tenn., Batesburg, S. C., and Orlando, Fla.

Mr. E. R. Speyer, of Cambridge, is at present in Washington and will study forest insects, starting in October for a visit to the far western forest insect stations. He will return to England in December and proceed to Ceylon for the purpose of studying the tea Scolytid.

Still another Carnegie scholar, Mr. H. G. Champion, is expected to arrive in October to study forest insects. He is a son of the well-known entomologist, Mr. C. G Champion.

Susceptibility of *Pollenia rudis* to Nicotine.—The "cluster fly" has been very numerous and quite annoying to the members of the staff in different laboratories of this Station during the past fall. It occurred to the writer to try a nicotine preparation (nicotine 90 per cent, water 10 per cent), which was applied by means of a small wad of cotton to the sills at the base of the window panes, the liquid being used in sufficient quantities to slightly moisten the wood. The effect on the flies was most marked, causing the death of a large percentage of the insects within a short period of time. This treatment has been frequently tested with similar results, and because of these experiences other laboratories in the institution have been influenced to use this method of destroying the pests. Black Leaf 40 proved to be equally effective as the foregoing preparation, although it is somewhat less rapid in its effects upon the creatures. With dark wood there was very little evidence of discoloration, but with windows coated with a light paint it would be desirable to place a narrow strip of cardboard on the sill before applying a nicotine preparation.

P. J. Parrott.

Mailed November 30, 1914.

INDEX

Acaroletis pseudococci, 148–49.
Adalia bipunctata, 348, 441.
Ædes cantator, 260.
  sollicitans, 260.
  sylvestris, 264, 265.
Ægerita webberi, 475.
Ageniaspis fuscicollis, 297.
Agonoderms pallipes, 477.
Agrilus bilineatus, 373.
  fagi, 438.
  politus, 438–40.
  sinuatus, 251.
  viridis, 438.
Agriotes mancus, 308.
Agromyza pusilla, 447–54.
  scutellata, 447–54.
Æolothrips fasciatus, 217.
Ainslie, G. G., 322–24
Alabama argillacea, 152–53, 405.
Alcohol, commercial, 272.
Aldrich, J. M., 404.
Allograpta fracta, 295.
  obliqua, 295.
Ammonia as a fumigant, 149–50.
Amphorophora rubicola, 136.
Anaphothrips striatus, 211–18.
Angumois grain moth, 204.
Anti-mosquito work, 260–68.
Apanteles lateralis, 187.
Aphanogmus floridanus, 330.
Aphelinus diaspidis, 227.
  fuscipennis, 227.
Aphidius testaceipes, 295.
Aphis atriplicis, 133.
  bakeri, 133.
  brassicæ, 440, 441, 443.
  frigidæ, 132.
  medicaginis, 295, 296.
  viburni, 440, 441, 443.
Apiary inspection, 92–97.
Apple tent caterpillar, 373.
Applied entomology, expenditures, 57; growth, 50–64; scope, 60; today's work, 64.
Argentine ant, 147, 153.
Arsenate of lead, properties of various forms, 162–67.
Arthrocnodax carolina, 330.
  constricta, 481.
  rhoina, 481.
Aschersonia aleyrodis, 475.
  flavocitrina, 475.
Aspidiotus camelliæ, 468.
  cyanophylli, 468.
  cydoniæ, 468.
  hederæ, 468.
  juglans-regiæ, 468.
  perniciosus, 422.
  tangæ, 250–51.
Atmometers, 249.
Aulacaspis pentagona, 298.
  rosæ, 468.

Baccha clavata, 295, 296.
Barbey, A., 350.
Bartonia bacilliformis, 357.
Bee-keeping in Missouri, 96–97.
Bee moth, observations on, 183–88.
Bichromate of potash, 269, 273.
Black leaf, 40, 195.
  weevil, 204.
Blissus leucopterus, 414, 415.
Boll weevil, 65–67, 234–40.
Botrytis bassiana, 474.
Bourne, A. I., 196–200.
Bracon brevicornis, 187.
Britton, W. E., 244–46, 257–60.
Brown-tail moth, 250.
Brown-tail and gipsy moth work, 83–87, 116–119.
Burgess, A. F., 7, 83.
Busck, August, 340–41.

Cabbage aphis, 440.
Cadelle beetles, 318.
Calandra oryza, 204, 206–10, 315.
Canadian entomological service, 298–99.
  nursery regulations, 151.
Cane beetle borer, 390–98.
Canis caraibicus, 359, 360, 362, 363, 364.
  criollus, 362.
Carbolic acid emulsion, 199.
  and lime, 199.
Carbon bisulfide, 188, 198.
Carpocapsa pomonella, 177.
Cathartus advena, 316.
  gemellatus, 204, 317.
Cavia cabaya, 361.
Cebus capuchinus, 358.
Cecidomyia viticola, 339.
Cereal products, 313.
Ceresa bubalus, 241.
Ceromasia sphenophori, 390, 454.
Ceroplastes sp., 469.
Chaitophorus sp., 128.
Chelonus texanus, 296, 297.
Chestnut borer, two-lined, 373.
Chiggers, 152.
Chinch bug, 414, 415, 416.
  parasite, 219–22.
Chittenden, F. H., 152.
Chloride of lime, 285, 286, 287.
Chrysomphalus sp., 468.
Chrysopa oculata, 330.
Clean culture, 332.
Clerid larva, 251.
Clover leaf weevil, 297.
Cobalt, 273.
Coccidæ of Peru, 466.

Coccinella 9-notata, 442, 443.
transversoguttata, 441, 443.
trifasciata, 441, 442, 443.
Coccinellid statistics, 440–43.
Coccus hesperidum, 469.
Cockerell, T. D. A., 148, 405, 459.
Codling moth, 251.
Colorado potato beetle, 152.
Conical grape gall, 339.
Confused flour beetle, 318.
Conotrachelus nenuphar 168.
Cooley, R. A., 193–95.
Coquillettidia perturbans, 264.
Cordyceps militaris, 474.
Corn (stored), reducing insect injury, 203–10.
bill bug, southern, 83.
root worm, western, 322–24.
Correspondence filing, 87–91.
Cotton, 327.
worm moth, 405.
Crosby, C. R., 408.
Culex pipiens, 257–60.
salinarius, 265.
Currant fruit fly, 193.
Currants, two new pests, 193–95.
fruit weevil, 193–94.
Current notes, 158, 254, 301, 354, 409, 484.
Cycloneda sanguinea, 441, 442, 443.

Davidson, W. M., 127–136.
Dean, G. A., 67–73.
Derostenus diastatæ, 453.
Dew, J. A., 162–67.
Diabrotica longicornis, 477.
12 punctata, 477.
Diapheromera femorata, 299.
Diaspis boisduvalii, 469.
echinocacti, 470.
Diplazon lætatorius, 294–97.
sycophanta, 295.
Dissosteira carolina, 82.
Drug store beetle, 317.

Eccoptogaster quadrispinosa, 374–75.
Eciton schmitti, 147.
Economic entomology, bibliography, 34–36.
Editorial, 154, 253, 300, 349, 407, 482.
Elis sexcincta, 388.
Empria fragariæ, 480.
Empusa sphærosperma, 297.
Entomological investigations, 7–22.
publications, efficiency, 26–34.
work in Missouri, 376–78.
Entomologists association, constitution amended, 38.
education of, 274–80.
employment bureau, 5.
executive committee report, 4.
incorporation, 22–24.
list of meetings, ix; members, xii.
membership committee, 44–45.
nominations, 46.
Entomologists association, secretary's report, 2.
26th annual meeting, proceedings, 1–97, 162–233, 257–94, 305–39, 357–78.
Entomophthora aulice, 475.
Ephestia kuehniella, 319.
Epicauta marginata, 477.
vittata, 477.
Epochra canadensis, 193.
Escherich, K., 350–52.
Eucallipterus arundicolens, 129.
Euceraphis betulæ, 129.
Eumicrosoma benefica, 220.
Eupachylomma rileyi, 403–404.
Eupelmus cereanus, 187.
Eupeodes volucris, 295.
Euproctis chrysorrhœa, 177.
Euthrips nervosus, 212.
striatus, see Anaphothrips.
Evaporation, studies of, 229–33.
Evetria buoliana, 340–41.
Ewing, H. E., 440–43.
Exoprosopa fascipennis, 387.

Felt, E. P., 148–49, 173, 339, 373–75, 458–59, 481.
Fernald, H. T., 196–200, 228–29.
Fiorinia fioriniæ, 470.
Flint, W. P., 476.
Flour beetle, confused, 204, rust-red, 204.
Forest tent caterpillar, 373.
insects, 373–75.
Formalin, 272.
Forestiere, Traite d'Entomologie, 350.
Forstinsekten Mitteleuropas, 350–52.
Fink, D. E., 149–50, 400–401.
Fruit insects, manual, 408.
Fungous diseases, 473–76.

Galleria mellonella, 183–88.
Gates, B. N., 348.
Gibson, Arthur, 201–203.
Gipsy and brown-tail moth work, 83–87, 116–19.
Gipsy moth, 250, 368–73; larvæ, 170; parasite search, incident, 378–82.
Girault, A. A., 445–47.
Glaser, R. W., 473–76.
Goodwin, W. H., 313–22.
Gooseberries, two new pests, 193–95.
Gossard, H. A., 31.
Grain beetle, sawtoothed, 204.
square-necked, 204.
louse, southern, 414, 415.
Grass thrips, 211–18.
Grasshopper baits, 68, 76, 78–81.
control, 67–73.
Green fruit worm, 189–91.
soldier bug, 336–39.

Hammar, A. G., 155.
Haseman, L., 96–97, 124–27, 376–78.
Headlee, T. J., 260–68, 413–17.

Heliothis obsoleta, 175, 405, 477.
Heilipus lauri, 243–44.
Hellebore, 198.
Hemerocampa definita, 370.
gulosa, 370.
leucostigma, 252, 370.
Hemichionaspis minor, 469.
Hemlock borer, spotted, 373.
Herrick, G. W., 189–92, 483.
Hewitt, C. G., 151, 195, 211–18, 281–89.
Hickory bark beetle, 373–75.
Hinds, W. E., 65–67, 203–10.
Hippodamia convergens, 441, 442, 443.
spuria, 441, 442, 443.
Hodgkiss, H. E., 227–28.
Hop aphis, 440.
Household insects, 483.
Horticultural inspectors, proceedings, 98–127, 234–44; certificates, 342–48.
House fly, 281–89, 268–73, 289–93.
Howard, L. O., 247–48, 274–80, 378–82.
Hunter, S. J., 293–94.
and Claassen, 73–82.
Hunter, W. D., 234–40, 289–92.
Hypera punctata, 297.
Hypoderma bovis, 195.
Hyslop, J. A., 305–12.

Icerya zeteki, 148.
Illingworth, J. F., 390–98, 444–45.
Incorporation, Entomologists, 22–24.
Indian meal moth, 204, 318.
Insect metabolism and moisture, 413–17.
resistant to sprays, 167–72.
Insectary, experience with, 181–83.
Inspection (nursery) administration, 119–23.
certificates standards, 342–48.
laws, 102–106.
notes, 240–44.
work, 124–27.
plant diseases, 106–108.
Iridomyrmex humilis, 147, 153.
Iron sulphate, 285, 287.
Isosoma grande, 403.
Itonididæ, zoöphagous, 458–59.

Jones, T. H., 460–62.

Kaliosysphinga dohrnii, 251.
Karschomyia cocci, 461, 462.
Kelly, E. O. G., 294–97.
Kermes waldeni, 150–51.
Kerosene emulsion, 199, 286, 287.
Killifish, 262.
King, J. L., 401–403.
King, G. B., 150–51, 246–47.

Lachnosterna, 382, 386, 389.
Læmophlæus minutus, 317.
Laphygma frugiperda, 461.
Lasius niger americanus, 476–78.
Leaf hoppers in Maine, economic notes, 192.
Lepidosaphes beckii, 471.
Leptinotarsa decemlineata, 152, 177.
Lepus cuniculus, 359.
Leucopis flavicornis, 404.
Lime-sulphur wash, 167–71, 195.
valuation, 463–67.
Limnerium disparidis, 378.
Limothrips avenæ, 217.
Liothrips montanus, 194–95.
Lithomyza condita, 460.
Lysiphlebus tritici, 414, 415.
Lissorhoptrus simplex, 433–39.
Litomastax truncatellus, 297.
Loxostege similalis, 296.

Macrosiphum ludovicianæ, 136.
Malacosoma americana, 175, 373.
disstria, 373.
Matheson, R., 141–47.
Mason, P. W., 252.
McColloch, J. W., 219–27.
McGregor, E. A., 324–36, 447–54.
Microweisia misella, 431.
Megilla maculata, 348.
Melanoplus atlanis, 67.
bivittatus, 67, 82.
differentialis, 67, 82.
Melander, A. L., 167–72.
Melanophila fulvoguttata, 373.
Mephitis mephitis putida, 252.
Meromyza americana, 212.
Merrill, D. E., 251–52.
Mesogramma polita, 295, 296.
Metcalf, C. L., 218.
Metcalf, Z. P., 83.
Microcerata iridis, 460.
Milk and formalin, 274.
Milk, sweet, 273.
Miscible oils, 173.
Mokshetsky, Sigismond, 247–48.
Morrill, A. W., 268–73, 342–48.
Mosher, F. H., 368–73.
Mosquito (anti) convention of New Jersey, 244–46.
Muir, F., 459–60.
Musca domestica, 281–89.
Myzus fragæfolii, 135.
Myzocallis quercus, 130.

Naphthaline, 200.
Newell, Wilmon, 87–91, 92–96, 147, 153.
New Jersey anti-mosquito convention, 244–46.
Nezara hilaris, 336–39.
viridula, 336.
Nicine, 198.
Notolophus antiqua, 370, 371.
Nun moth, 474.

O'Kane, W. C., 7–22, 181–83.
Onion maggot, 197–200.
thrips, 196–97.

Orton, W. A., 109–16.
Orthezia insignis, 471.
Osborn, Herbert, 192.

Paddock, F. B., 183–88.
Palmer worm, 191–92.
Parker, J. R., 136–41.
Parks, T. H., 297, 417–21.
Parlatoria blanchardii, 243.
Parrott, P. J., 50–64, 227–28, 487.
Peach, arsenate injury, 165.
borer, lesser, 401–403.
Peairs, L. M., 152–53, 174–79.
Pear thrips, 478–79.
Pecan twig girdler, 218.
Pellegra, 293–94.
Pemphigus betæ, 136–41.
californicus, 127.
Perissopterus pulchellus, 227.
Perkinsiella saccharicida, 243.
Peruvian coccidæ, 467–73.
Phænicococcus marlatti, 243.
Pheidole megacephala, 396.
Phlebotomus verrucarum, 357.
Phorodon humuli, 440, 441, 443.
Phylloxera vastatrix, 297.
Phytonomus posticus, 417–21.
Picea englemanni, 246.
Pine moth, 340.
~~Pissodes strobi, 375.~~
Plant louse notes, 127–36.
quarantine, 109–16.
Plodia interpunctella, 204, 318.
Plum curculio, 168.
Poison resistance, 170.
Poisoned bran, 202.
Pokeweed, 327.
Pollenia rudis, 487.
Polygnotus hiemalis, 297.
minutus, 296, 297.
Popenoe, E. A., 155.
Porosagrotis delorata, 201–203.
orthogonia, 203.
Porthetria dispar, 178, 371.
Porto Rican sugar cane insects, 461–63.
Posthörner, 340.
Potassium sulphid, 335.
Potato weevil, 242.
Prenes ares, 462.
Prospaltella berlesei, 298.
perniciosi, 227, 422–32.
Pseudanthonomus validus, 193–94.
Pseudaonidia articulatus, 471.
Pseudococcus calceolariæ, 460.
citri, 148, 472.
sacchari, 461.
Pseudokermes cooleyi, 246–47.
Pulvinaria sp., 472.

Red spider, 324–36.
Reviews, 350, 408, 483.
Rhabdocnemis obscurus, 390, 444, 455.
Rhagoletis pomonella, 398–400.
Rhigopsidius tucumanus, 242.
Rhopalosiphum corylinum, 134.
Rhipiphorus pectinatus, 383, 387.
Ribes setosum, 194, 195.
Rice water weevil, 433–39.
Rice weevil, 204, 206–10, 315.
Riley, W. A., 157.
Rogers, D. M., 116–19.
Rohwer, S. A., 479–81.
Rose, agrilus infesting, 439.
Rotation, 333.
Rust, E. W., 467.

Saissetia hemisphærica, 471.
oleæ, 471.
San José scale, 141–47, 167–71, 422.
parasites, 227–28, 229.
Sand fly, 293–94.
Sanders, J. G., 102–106.
Sasscer, E. R., 240–44.
Scarabæid larvæ rearing, 445.
Scientific notes, 154, 250, 297, 339, 348, 405, 483.
Scolothrips sexmaculata, 331.
Scott, W. M., 478–79.
Serpentine leaf miner, 447–53.
Shelford, V. E., 229–33, 249.
Sherman, Franklin, 348.
Signiphora nigrita, 227.
Silvanus surinamensis, 204, 316.
Simulium vittatum, 293.
Sitotroga cereallela, 204.
Sitodrepa panicea, 317.
Slingerland, M. V., 408.
Smynthurus sp., 400–401.
Soap wash, 198.
Sodium cyanide, 307.
Soil fumigation, 305–12.
Spaulding, Perley, 106–108.
Spilogale interruptans, 153.
putorius, 252.
Sphenophorus nebulosus, 445–46.
Sporotrichum globuliferum, 474.
Spring-tails, 400–401.
Sterility in oats caused by thrips, 211–18.
Stethorus punctum, 330.
Stomoxys calcitrans, 459–60.
nebulosa, 459.
pallida, 459.
Strawberry, 479.
Sugar beet root louse, 136–41.
cane insects, 444, 461–62.
cane weevil borer, 455.
maples, 173.
Sulphur, 188.
Swezey, O., 455–57.
Synanthedon pictipes, 401.
Syrphus americanus, 295, 296.

Tachinid parasites, 390–98, 455.
Tæniothrips pyri, 478–79.
Tapinostola musculosa, 298.
Tarsonemus spinipes, 463.
Tartar, H. V., 463–67.

Temperature, high, 313–22.
and oviposition, 417.
relation to insect development, 174–79.
Tenebrio molitor, 177.
Tenebrioides mauritanicus, 318.
molitor, 318.
Tetranychus bimaculatus, 324, 481.
Tetrastichus asparagi, 296.
Thrips cerealium, 212.
tabaci, 196–97.
Tiphia inornata, 382–89.
Tolype laricis, 371.
Tower, D. G., 422–32.
Townsend, C. H. T., 357–67.
Toxoptera graminum, 403–404, 414, 415.
Tribolium confusum, 204, 316, 318.
ferrugineum, 204.
Triphleps insidiosus, 330.
Trogoderma ornatum, 317.
Trombidium sp., 152.

Vaccinium species, 398.
Verruga work, progress, 357–67.

Walking stick, 299.
Warble fly, occurrence in Canada, 195.
Washburn, F. L., 34, 64, 348.
and Spangler, A. J., 119–23.
Webb, J. L., 432–38.
Webber, R. T., 368–73.
Webster, F. M., 403–404.
Webster, R. L., 33.
Weiss, H. B., 250–51, 438–40.
Wheat stem maggot, 212.
White grubs, 382, 386, 389.
pine weevil, 375.
Whitmarsh, R. D., 336–39
Wire worms, 308.
Wolcott, G. N., 382–89.
Woods, W. C., 398–400.

Xylina antennata, 189–91.

Ypsolophus ligulellus, 191–92.
pometellus, 191–92.

Zacher, F., 483.
Zagrammosoma multilineata, 454.
Zelus rubidus, 462.
Zenoleum, 286, 287.
Zoöphagous itonididæ, 458–59.

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